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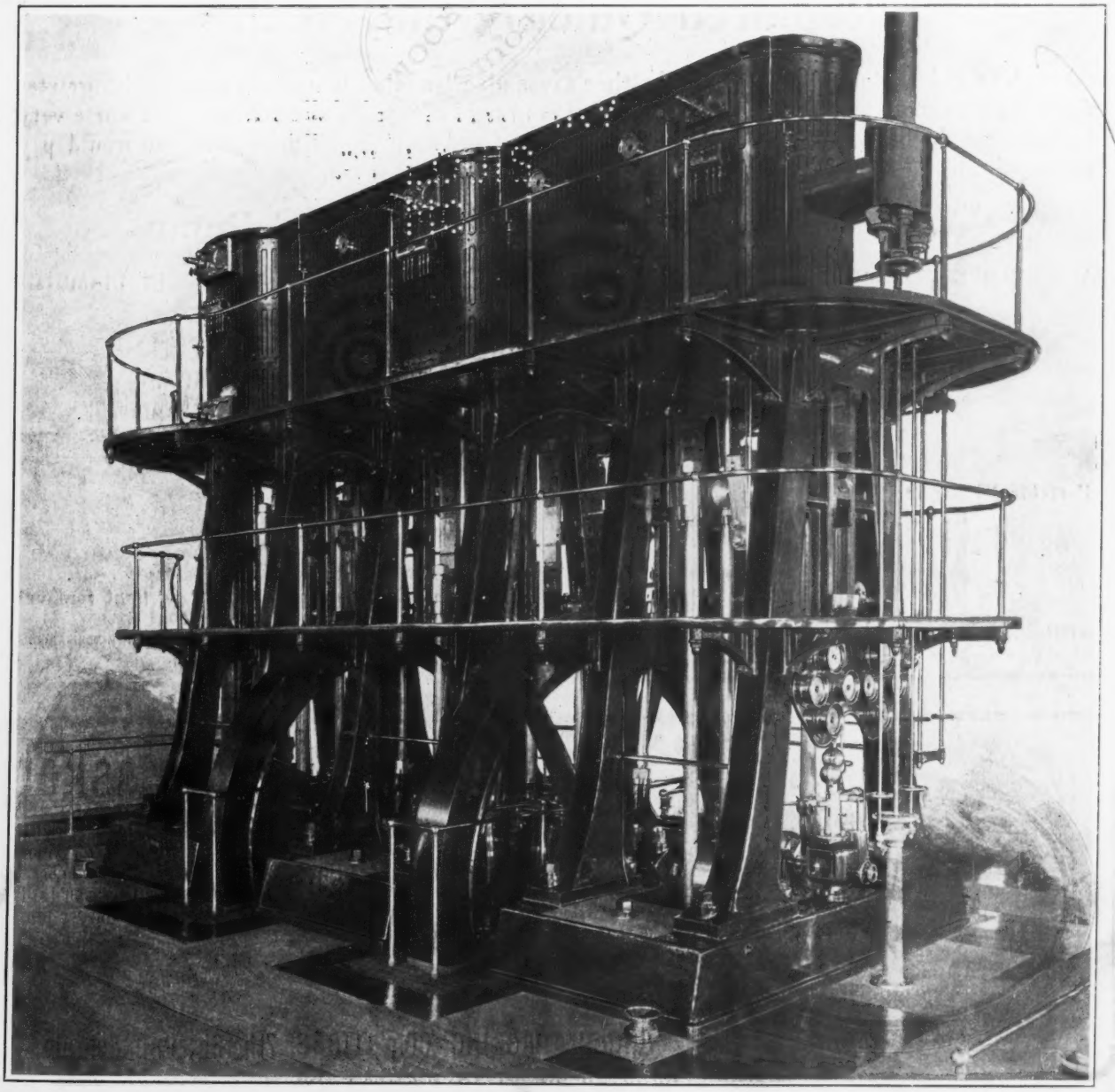

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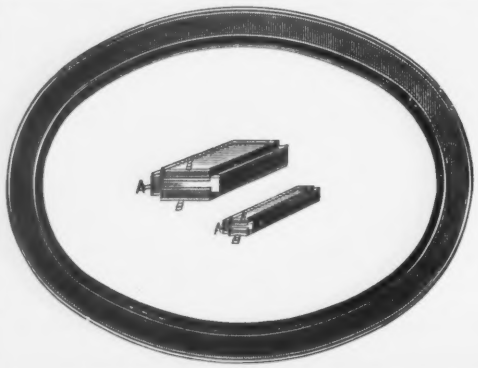

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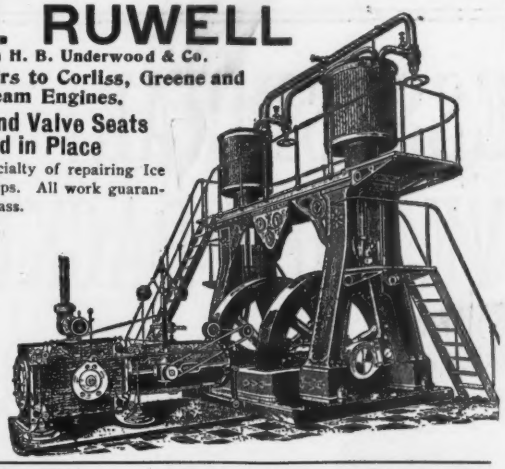

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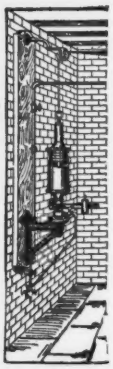

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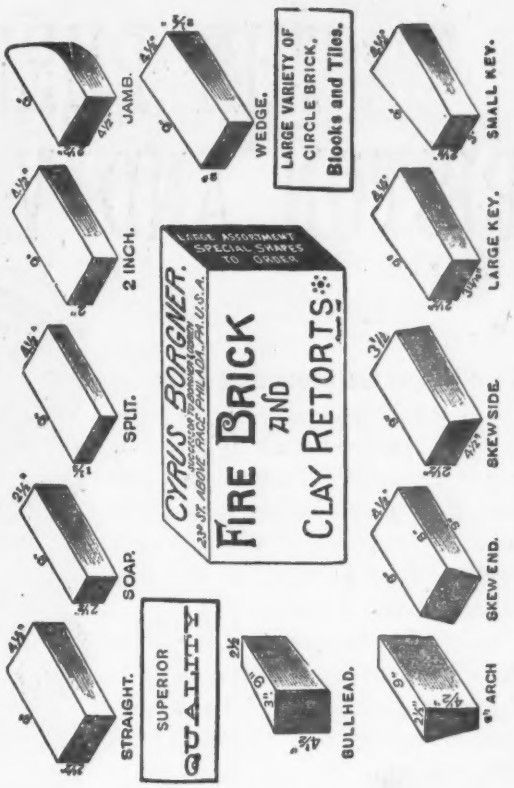

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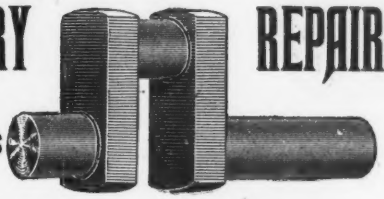

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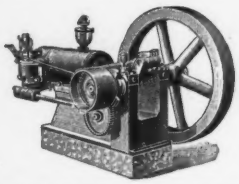

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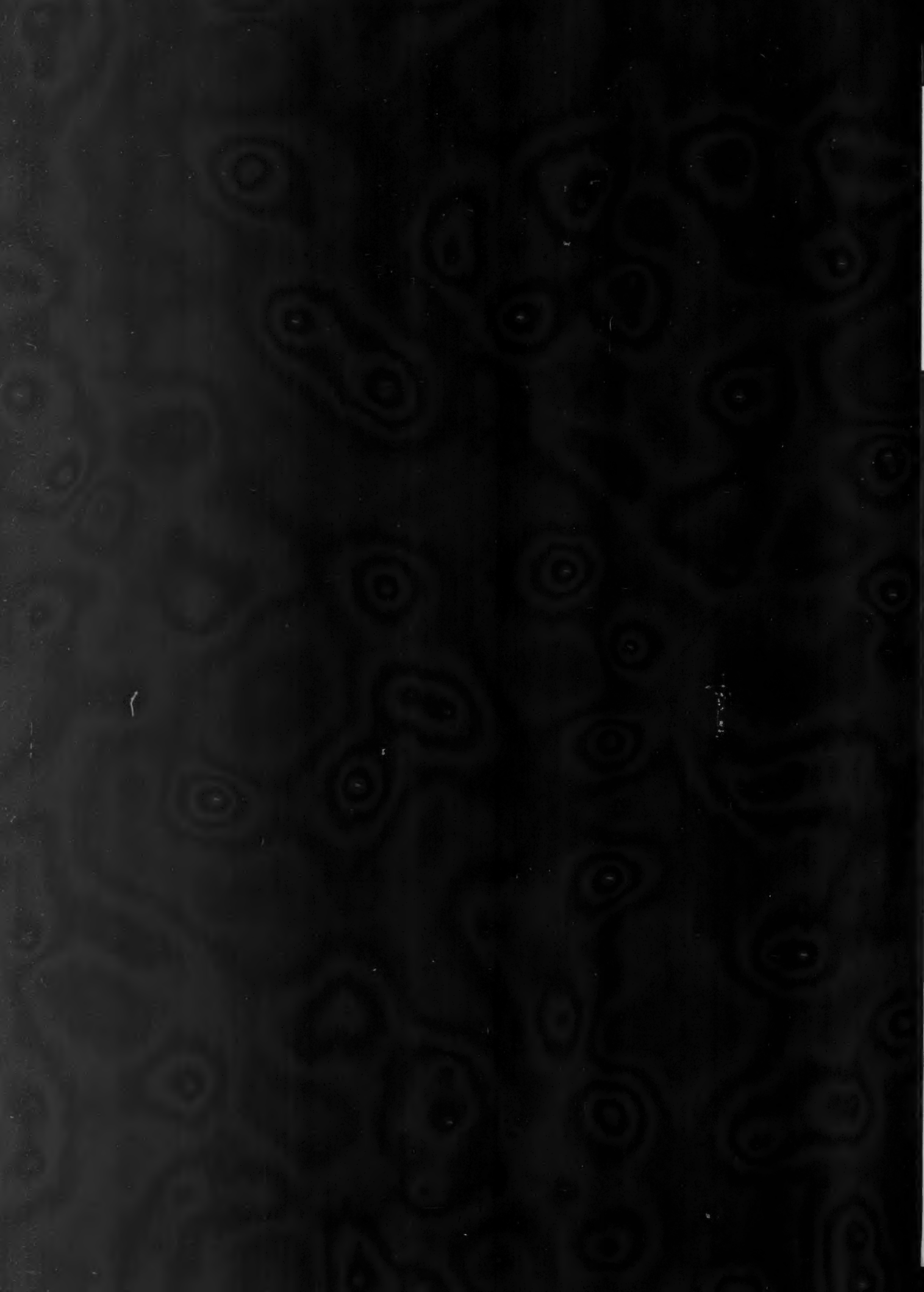

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The Relation of Boiler to Furnace

By R. T. STROHM

As commonly understood, the steam boiler consists of a vessel containing water, having underneath it, or conveniently located within it, a furnace for the purpose of burning fuel, and thus converting the water into steam. Properly, however, the steam boiler is simply the vessel which contains the water, and its office is to transfer the heat generated by the furnace to the water in order to evaporate it into steam. In other words, the boiler is simply the heater or evaporator.

The furnace has an entirely separate and distinct function. It transforms the latent or chemical energy of the coal, or other fuel, into sensible or heat energy in such a form that it can be absorbed by the boiler. Having performed this, its office is fulfilled, and it is the duty of the boiler, then, to take care of the heat thus generated. The furnace does not have anything to do with the evaporation of the water. Its sole purpose is to burn the fuel.

The efficiency of the entire apparatus is the ratio of the heat put into the furnace in the shape of coal to the heat actually utilized in evaporating water, and this, of course, must depend upon two things. The first is the efficiency of the furnace, and the second is the efficiency of the heater or evaporator. The efficiency of the apparatus is then the product of these two efficiencies.

Unfortunately, it is a very difficult matter to obtain these efficiencies separately. The efficiency of the furnace is the ratio of the amount of heat which is liberated by the combustion of the fuel, and is available for use in evaporating water, to the total amount of heat which is put into the furnace in the shape of latent or chemical heat in the fuel. The efficiency of the boiler is the ratio of the heat used in evaporating water to that generated during combustion.

In the ordinary boiler trial, a calorimetric test is made of the coal used, and the amount of coal fired in a given time is noted. The amount and pressure of the steam generated in the same time is also carefully recorded. In this way the amounts of heat put into the boiler and taken from it are computed and the total efficiency determined. But this does not tell how well each part of the apparatus performed its duty. The heater may be very efficient and the furnace very inefficient, or the furnace may be very efficient and the heater very inefficient, and yet the total efficiency obtained be fairly good.

There is no known way in which the products of combustion can be collected immediately after being formed so as to determine the exact amount of heat which they contain before they come into contact with the evaporator. Nor is there any method by which the percentage of this heat transferred to the evaporator and thence to the water can be definitely arrived at. The best that we can do is to determine these approximately by observing the condition of the heating surface and the temperature and composition of the flue gases as they leave the boiler surfaces.

The total heat in the coal as determined by calorimetric test, minus the various heat losses in the furnace, gives the amount of heat which is available for evaporating water. So that the less the heat losses the greater the efficiency of the furnace.

The heat losses in the furnace may come about in a variety of ways. In the first place, the combustible portions of the fuel may not be completely oxidized. That is, a portion of the fuel, and consequently a portion of its chemical heat, will not be converted into sensible heat. Instead, it will pass out in the flue gases and become a complete loss. This is known as the loss by incomplete combustion, and the best example is the formation and escape of carbon monoxide or CO.

All solid fuels, such as are available for use under boilers, have a certain amount of incombustible matter, known as ash, in their composition. This residue, when it falls into the ash-pit, carries away a certain amount of heat, and is another, though slight, source of loss.

The question of excess of air does not enter into nor af-

fect the efficiency of the furnace. The same amount of heat will be generated whether just enough air is supplied or whether the excess is allowed to be 100 per cent. In the former case, the volume of the gases will be a minimum, and the temperature will be a maximum. In the latter case, there will be the same amount of heat in the gases, but their volume will be much greater, and as a consequence their temperature will be much less. But since the efficiency depends solely upon the number of heat units resulting from combustion, and this is constant in both cases, the efficiency is not affected.

The efficiency of the heater, or the evaporator, depends upon the amount and condition of its surfaces. That is, the greater the area exposed to the hot gases, the larger will be the amount of heat absorbed from the hot gases and transmitted to the water. And if the plate is covered with scale inside, and with deep layers of soot outside, it is reasonable to conclude that it cannot absorb as much heat as it would if the surfaces were quite clean.

The boiler can influence to a great extent the efficiency of the furnace according to the location of the heating surfaces. These may be placed so as to aid in extracting the greatest possible amount of heat from the gases, or they may be so placed as to seriously hinder the proper action of the furnace.

We hear and read a great deal about incomplete combustion and the smoke nuisance, and every manufacturing city or town of any importance is urging legislation directed toward smoke abatement. This, in a great majority of cases, is misdirected energy. For some boilers—yes, many boilers—are built in such a way that they can do nothing but smoke, and smoke they will in spite of careful firing and city ordinances to the contrary.

Carbon and oxygen, the principal elements which enter into combustion in the furnace, do not combine at ordinary temperatures. Below a temperature of 800° F. carbon will not unite with oxygen. This means, therefore, that if combustion is to continue, the temperature of the furnace is to be maintained above 800° F. at the least. Now, this is not a difficult matter, for temperatures of 3,000° F. are not at all uncommon in furnaces. But this rule extends further.

After carbon and oxygen are once united into carbon dioxide the combustion is complete, and no amount or degree of heat or cold can change the compound. However, if the carbon and oxygen atoms are dissociated by the heat of the furnace, and the combustion only partially completed by the formation of CO, carbon monoxide, then if the temperature be lowered to a point below 800° F., combustion will be stopped, and the carbon monoxide will pass out with the flue gases, unable to give up the remainder of its chemical heat. Thus there will be a loss of heat and likewise a lowering of furnace efficiency, since the furnace will have transformed less of the latent heat of the coal into sensible heat than it should have done. A pound of carbon burned to carbon dioxide, or carbonic acid gas, will yield 14,600 heat units, whereas only 4,400 are realized when the same weight of carbon is burned to form carbon monoxide.

The location of the heating surfaces has a great deal to do with causing losses like this. If they are too close to the furnace the hot gases arising from the fuel bed are chilled before they have had the time to burn completely, and this means smoke, loss of heat and lower furnace efficiency.

Combustion is not complete at the surface of the fuel on the grates. With a fuel rich in volatile matters, burned with a strong draft, the flames may be drawn back through the combustion chamber into the tubes, showing that combustion is even there continuing. To thrust the shell or the tubes of the evaporator, chilled by their contained water, into the path of these gases, means that before combustion can be completed the temperature of the products of combustion will be so lowered that combustion will be only partial, and the carbon, which is thus reduced below its combining temperature, will appear free in fine particles as the coloring matter of smoke.

This is, in brief, just what occurs in the furnaces of many boilers, and those of water tube boilers are especially at fault, since the surfaces are so placed as to more thoroughly break up the currents of the gases, and so the more readily chill them. The water tube boiler is a better evaporator than the return tubular boiler because its heating surfaces are so arranged as to present greater wetted areas to the action of the hot gases on the other side, and also because the currents of these gases are more thoroughly broken up. But as a furnace, the water tube boiler is far from being ideal, because it has its evaporator in too close proximity to the furnace.

The boiler makers and designers are not wholly to be blamed for this. To separate the furnace and the evaporator by any appreciable distance means an increase in the amount of space required by a boiler of any given evaporative capacity, and the usual demand of the purchaser is that the boiler shall occupy the least space possible or consistent with the designed capacity. In the design of the boiler, therefore, efficiency must be sacrificed somewhat to space.

Smokelessness is by no means an impossibility. It depends largely upon the relative locations of the furnace and the evaporator. If the design is correct, so that there will be ample space in which combustion may be carried to its completion before even touching the surfaces of the heater, then, no matter how much heat is extracted from the gases, there will be no smoke. But if the water tubes or the shell of the heater are crowded around or over the furnace, then the owner of the apparatus may as well prepare to pay fines for smoke nuisances.

There are countless devices which aim to prevent smoke formation, but the only ones which have met with any success in general, rather than specific, instances are those which employ the idea of a furnace distinct from the evaporator, so that each may perform its separate duty to the best advantage and with the highest efficiency.

It is true that such a design means increased cost, for it requires a larger and more perfect setting, which must include an ample space for combustion as well as enclose the evaporator. To prevent loss by radiation the furnace must be made of refractory material, which will keep the heat in the furnace, where it belongs, until it is ready to be passed on to the heater.

These facts are well known and have been for a long time, yet in few instances have they been given practical application. With the increasing outcry against smoke, and the efforts that are being put forth to subdue the evil, it is reasonable to suppose that sooner or later it will be seen that the only complete and satisfactory solution depends wholly upon placing the furnace and the boiler so that each shall attain its highest efficiency unhindered by the other.

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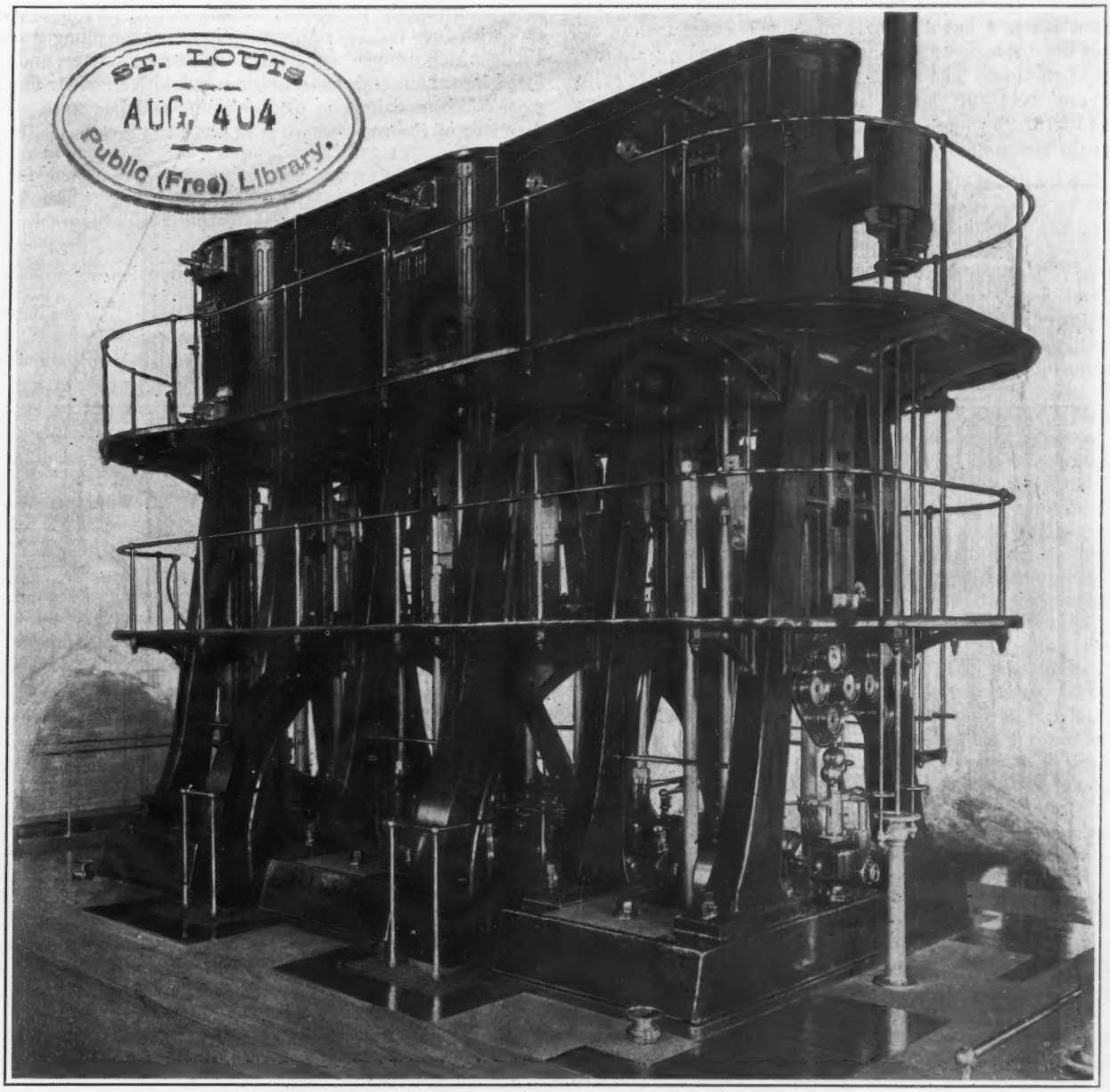
The Barr Pumping Engines, at Water Works, Harrisburg, Pa.

The illustration on the front cover of this edition shows the new pumps recently installed by the Barr Pumping Engine Co., of Philadelphia, at the Harrisburg, Pa., Pumping Station. The Station is situated upon the banks of the Susquehanna River, at the western end of the town, and is considered one of the features of the city.

The accompanying line engraving shows clearly the cylinder and valve arrangement, they being arranged side by side with the three cranks set at angles of 120°, and are fitted with Corliss valves located in the cylinder heads.

The cylinders are 28, 48 and 72 inches in diameter.

The stroke common to all the cylinders is 42 inches, and the engine is designed to pump twelve million gallons in 24 hours, against a head of 87 pounds at 37 revolutions, or 222 feet of piston speed per minute, with a boiler pressure of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Twelve Million Gallon Barr Pumping Engine, at Water Works, Harrisburg, Pa.

Prior to the present installation of Barr pumping engines the plant was equipped with two horizontal high-duty Worthington pumps. These becoming inadequate for the work demanded of them, it was decided to add the additional pumping power. In accordance with this the plant was remodeled and an addition built to accommodate the new pumps.

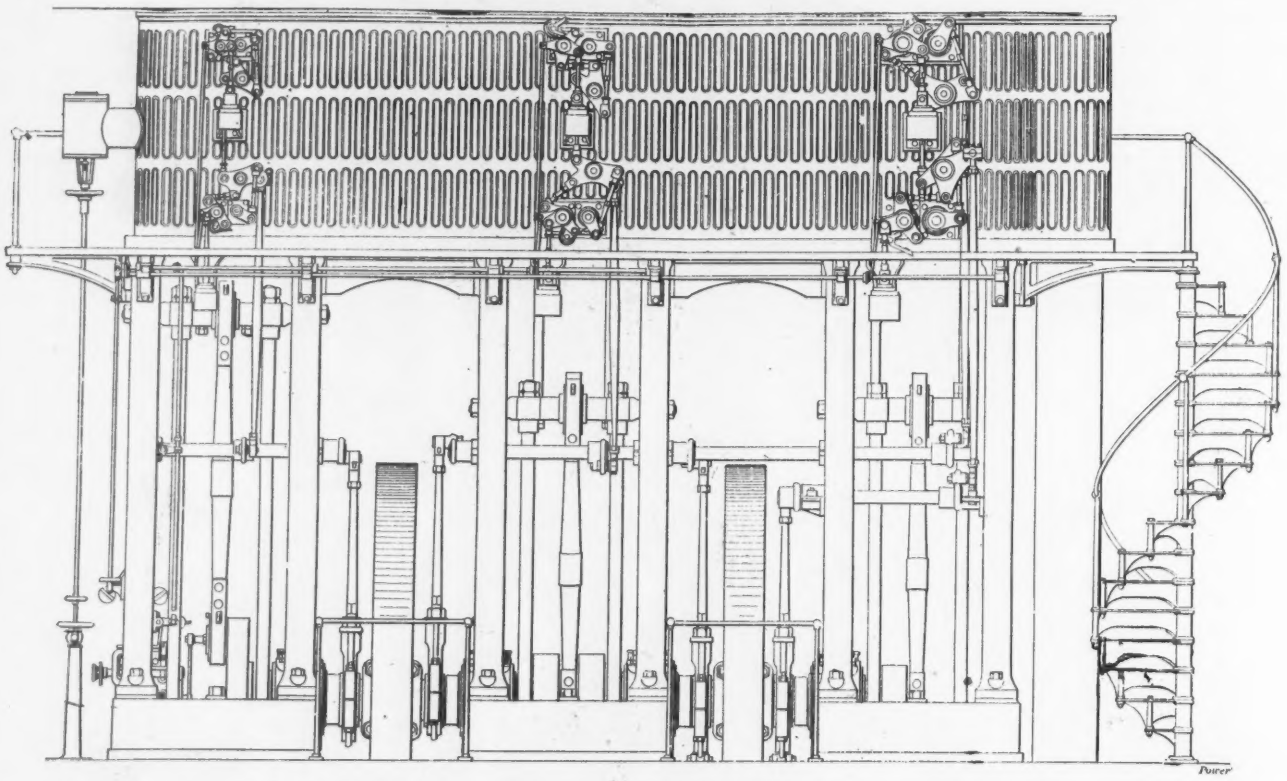
150 pounds condensing.

The jackets of the high-pressure cylinder and the tubes of the first receiver are charged with steam of full boiler pressure, those of the intermediate cylinder and of the second receiver with steam wire drawn by a reducing valve to a pressure ten pounds above that in the receiver and the low pressure cylinder jacket by a further reduction by means of a

reducing valve between the low pressure receiver and the low pressure cylinder. Steam is brought to the engine in a five-inch main, having an area of about 18 square inches. The steam ports of the high pressure cylinder are $1\frac{1}{4}$x18=22.50 square inches in area, and the exhaust $1\frac{3}{4}$x18=31.5 square inches. The first receiver has a volume of 50,000 cubic inches, 4.5 times the displacement of the high pressure piston, and 1.4 times that of the intermediate. The steam ports of the intermediate are $1\frac{3}{4}$x30=52.5 square inches, and the exhaust ports 2x30=60 square inches. The second receiver has a volume of 80,000 cubic inches, 2.3 times the displacement of the intermediate, and a little over that of the low. The steam ports of the low pressure cylinder are 2x45=90 square inches, and the exhaust ports $2\frac{1}{2}$x45=101.25 square inches. A 14-inch exhaust pipe conveys the steam finally to a surface condenser. Steam can be

The bearings, of which there are four, are each 18 inches in length. The two end crankpins are 6 inches in diameter and 6 inches long, while the intermediate pin is $7\frac{1}{2}$x6 inches. The fly wheels, of which there are two, are 12 feet in diameter, cast in two pieces, and weigh 15,000 pounds apiece.

The crossheads of the pump are heavy steel forgings, having the crankpins turned on each end of the crosshead itself. It is provided with four lugs, which are drilled for the reception of the plunger rods, or what are sometimes called parallel rods. These four rods straddle the crank and shaft and reach down to the plunger crosshead, which is a square steel slab with four holes for the reception of these plunger rods. Plunger rods are made of steel, 4 inches in diameter, and are fitted into the crossheads on either end with shoulder fit and steel collar, and held in place by nuts and jam nuts. The diameter of the rods, where it fits into the crossheads, is $3\frac{1}{2}$ inches.



by-passed to the intermediate cylinder for starting up, and the connections between the cylinders and the receivers are made with copper pipe of such flexibility as to take up the expansion. The reheating surface consists of one-inch copper pipes, extending upward from a steam box in the bottom of the receiver and capped on their upper ends, forming "porcupine" tubes. Of this pipe there are 350 feet in the first receiver and 475 in the second, giving 91.63 square feet and 134.35 square feet respectively. There are two steel piston rods in each cylinder, each $2\frac{3}{4}$ inches in diameter. The crossheads are steel forgings, and carry both the connecting rod and plunger rods. The crosshead pins are 7x6 inches.

The main shaft is 12 inches in diameter, made in two pieces, with crank webs on both ends of each. The cranks of the high and low pressure cylinders are overhanging, while the pin of the intermediate crank spans or connects the webs on the interior ends of the two portions of the shaft.

The water plungers, of which there are three, are $20\frac{1}{4}$ inches in diameter, outside packed. The water cylinders are cast in two sections. The valves are spring-seated, brass with hard rubber facings, having each a free area of 7.05 square inches. In the suction deck are 84 of these valves, giving a total clear area of 184 per cent. to the cross section of the plunger. In the delivery deck 72 valves are used, giving an aggregate area of 157.5 per cent. of the plunger section. An independent surface condenser is used, with an 8-inch steam, 12-inch water, and 12-inch air cylinder, and a 12-inch stroke. It takes the circulating water from and returns it to the main pump section, and exhausts through a heater into the condenser.

Steam is furnished to the pumps by a battery of seven boilers of the return tubular type, 72″ by 18′, arranged with overhead flues. Two of the boilers are fired by automatic stokers, the others being hand-fired.

High Pressure and High Temperature

While in the march of progress we have been gradually raising steam pressures, we have kept pace with the corresponding increase of temperature by improvements in construction until we have already moved the barriers and paved the way for the introduction of super-heated steam.

While it is difficult to form an exact estimate, there have probably been as many as 7,000, and possibly more, superheaters successfully installed by European manufacturers during the past ten or fifteen years, and the fact that the number of installations is rapidly increasing is the best proof that they are on the right track.

For a wide range beyond the temperature and corresponding pressure at which it is formed, steam possesses all the properties of a perfect gas, and therein lies one of its chief values as a vehicle for carrying heat into an engine to be transformed into power. Steam is so generally used in an engine because of its high latent heat, which allows the loss of a considerable amount of heat before condensation begins. But without super-heating we stop at the threshold, whereas we might easily continue on to a place of safety, and instead of passing the steam through the engine on the ragged edge of condensation, it is easily within our reach to fix the gas permanently by raising it in temperature and adding enough heat units to supply the demands, both useful and wasteful, while it is passing through the engine.

Much of the indifference to super-heated steam has been due to the unreliability of the super-heater, which has not always been of proper design; but at the present time there is no difficulty in obtaining a suitable and efficient apparatus at a reasonable cost. There are several good makes on the market, each possessing advantages of its own.

The general method of super-heating steam is to take the saturated steam from a boiler drum and pass it through coils surrounded by heated gas. The coils may be placed within the boiler setting so as to intercept the gases from the boiler furnace in their passage through the boiler, or they may be placed in a setting independent of the boiler and supplied with heat by a furnace of their own, or they may be set outside of the boiler and supplied with heat by drawing a portion of the gases from the boiler furnace, passing it through the super-heater and returning it to the boiler or economizer.

The coils are made of seamless drawn steel tubing or of cast iron of a suitable composition to stand high temperatures, important advantages being claimed for each. Whatever the method of construction adopted, the material used must be of the very best and the joints and connections made in the most approved manner, and with the greatest care. With such precautions as are now considered good practice, the super-heater may be depended upon as safely as the boiler, or engine, or any other part of the plant.

In considering the advantages and disadvantages of superheating with regard to engine work, take cognizance of the four distinct conditions under which steam is used, namely, saturated, super-dried, moderately super-heated, and highly super-heated.

Saturated steam may be taken as commercially dry steam, or such as is delivered by a good boiler under ordinary conditions.

By super-dried steam the author means steam which is not only thoroughly dried in the super-heater, but which is raised in temperature thirty or forty degrees above the saturation point, or just enough to insure its arriving at the engine in a perfectly dry state. To such an arrangement there could possibly be no objection, as the steam is delivered at the engine free from moisture and without the use of a separator or means of trapping out condensation.

By a moderate super-heat is meant from 100° to 150° at the boiler, which should give in the neighborhood of 100° at the engine and be sufficient, with proper protection, to carry the steam nearly, if not quite, through one cylinder without condensation. If the engine is compound, the steam, having lost its heat at the terminal point of the high-pressure cylinder, is re-superheated about 100° in a reheater between the high and low-pressure cylinder, will give an excess of super-heat while expanding into the low-pressure cylinder, arriving at the point of exhaust with the temperature of saturation. This arrangement may be considered at the present time as the best which can be proposed. The amount of super-heat is so moderate as not to require anything more than good construction for modern high-steam pressure.

Highly super-heated steam must be treated with more consideration. Engines which will stand a temperature of 500° Fahr. are not necessarily fitted to handle steam at 750°, but these temperatures may be, and have been repeatedly, used successfully. To employ these high temperatures it is at present considered important to use poppet valves on the high-pressure cylinders at least, as it is here that the full effect of super-heat is felt, and this type of valve is easier to lubricate and does not become distorted with heat. The author believes, however, that a Corliss valve may be so proportioned as to operate successfully under even these conditions.

One of the well-known methods of utilizing super-heat is that known as the Schmidt system. This consists in passing a portion of the highly super-heated steam directly from the boiler through the reheating tubes of a receiver, between the high and low-pressure cylinders of a compound engine, and then letting this steam mix with that which enters the high-pressure cylinder direct from the boiler. The high-pressure exhaust is thus super-heated on its way to the low-pressure cylinder, while the temperature of the steam admitted to the high-pressure cylinder is modified by its admixture with steam which has already been through the reheater coils; and, incidentally, a receiver drain is unnecessary. Automatic regulation of the super-heat to a desirable point in each cylinder under a varying load is claimed for this system. Ordinarily an increase of load beyond normal, necessitating a late point of cut-off in the high-pressure cylinder, will give an excess of super-heat in this cylinder, while the reheater will not be sufficiently active to superheat this steam on its way to the second cylinder. With the Schmidt system, however, the effect is reversed by causing a greater amount of steam to pass through the receiver coils, where it gives up its super-heater to the low-pressure cylinder during the periods of heavy draught, and the high-pressure cylinder is thus protected from excessive heat. The contrary effect in both instances may be followed through in case of an engine running under a light load.

In the present state of the art it would seem that the condition most attractive to American engine builders would be one of moderate super-heat. We thus confine ourselves to a conservative policy and avoid the necessity for making any special provision for extremely high temperature. We use lubricants, gaskets and packing which may be obtained in open market at a reasonable cost, while at the same time we avail ourselves of such positive and direct benefits of super-heating as dry steam in the pipes throughout the engine; elimination of the separator; low steam consumption per unit of work done; smaller steam pipes and ports; a simplified system of steam jackets; a greater amount of work

done per unit of boiler capacity, and better efficiency at light loads. These are all practical improvements, and are of such proportion as to justify attention.

The absence of water with the steam need not be dwelt upon. Every practical man will admit that this is of great value. It is further noticeable that a steam pipe system which will show leakage at the joints with saturated steam will become perfectly tight under super-heated steam.

The point of maximum economy while using super-heated steam has by no means been reached. The amount of data available is not in proportion to the extent of the practice.

In order to make a comparison between super-heated and saturated steam consumption of an engine it is, of course, only fair to place both on a heat unit basis, thus eliminating entirely the question of the cost of the super-heat. Assuming a compound engine of about 1,000 horse-power and running with 150 pounds initial pressure and 26 inches vacuum, we would consider 12½ pounds of fuel per indicated horse-power per hour a very good result. I have authentic reports of a similar engine supplied with steam with a temperature of 720° Fahr. at the boiler, consuming less than 9 pounds of steam per indicated horse-power, or a gain of 39 per cent. in economy with an expenditure of but 16 per cent. more heat units in the boiler.

The reduction in the size of steam pipes and ports rendered possible by using super-heated steam is due to the diminished density of an equal volume as compared with saturated steam, as well as from the absence of entrained water. The velocity of super-heated steam in pipes should be kept up in the neighborhood of 6,000 feet per minute. As a rough approximation it may be said that super-heating will make a difference of 20 per cent. in the size of the steam pipe.

The question of steam jackets on a cylinder, which has been given so much profound attention in recent years, is quickly solved by the aid of super-heated steam, and we see disappear at once the benefit of the jacket as a steam economizer. There seems to be no excuse for retaining the jacket on the low-pressure cylinder, and indeed we have proved by trial that on this cylinder a steam jacket is positively wasteful.

We do not think it is clearly proved, however, that they may not still be useful when applied to the high-pressure cylinder, if only for the sake of warming up a large engine preliminary to starting.

The effect of getting more work out of a certain volume of steam is naturally felt in the handling of the boilers and in a reduction of fires necessary to do a given amount of work. Unexpected results have been frequently obtained by the addition of a super-heater to a boiler, and a higher evaporative efficiency with the super-heater in commission has been shown. This is doubtless due to the increase of the heating surface and the lowering of the temperature of the flue gases. In such cases the saving by super-heating is felt in the coal pile to the same extent as in the steam consumption.

On the acceptance test of some vertical compound engines of 1,200 and 2,400 horse-power on electric light service in Boston the maintaining of efficiency under light loads was well demonstrated. The feed water per indicated horse-power per hour was 12.54, 12.51 and 12 pounds, at full load, three-quarter load and one-half load, respectively, while the amount of super-heat was 80 degrees, 64 degrees and 48 degrees, respectively, at the high-pressure admission, and 60 degrees, 67 degrees and 84 degrees, respectively, at the low-pressure admission. The engine had reheaters and steam jackets on both cylinders, and it is not unlikely that still better results would have been obtained had the low-pressure cylinder jackets been omitted. It must not be considered necessary to make any very extensive preparations for the use of super-heated steam; it may almost be said that the requirements are merely in the line of good practice, and, as such, should be inaugurated in any event. It is important to have the joints of the steam pipes firmly made and well bolted; corrugated brass gaskets are usually found very satisfactory with super-heated steam. Provision must, of course, be made for the expansion and contraction of the steam lines to a somewhat greater extent than ordinarily, and the steam pipes, including flanged unions, should be covered with a thick layer of good non-conducting material. It is important to have the flanged unions covered as well as the pipe. With proper precautions of this sort and with a velocity of steam in the pipes of from 4,000 to 6,000 feet per minute, the drop in temperature per foot of run may easily be kept down to one degree in six or seven feet of length.

Metal of low melting point must, of course, be avoided in the construction of the engine, especially about the valves and piston rods. The stuffing-box bushings must be made of metal which will not run under the temperature likely to be encountered. The metal should be uniformly distributed in designing the valves and cylinders to get the best results with super-heated steam, as in this way a uniform expansion by heat is provided for. The barrels of the cylinders are preferably made without projections or ribs. The poppet valve has the advantage in form, but the Corliss valve is also made in such a manner as to expand and contract without warping, and the large number of Corliss engines using super-heated steam is a strong evidence of their adaptability.

The lubrication of the cylinders is apt to cause one who has not had experience with super-heated steam a great deal of unnecessary anxiety, but really this problem is very simple. It must be borne in mind that the temperature inside of the cylinder is never very high, even when the super-heat at the entrance is very considerable, and if the cylinder is lubricated directly without mixing the oil with steam at the entrance point there can possibly be no difficulty. With any reasonably good grade of mineral oil, however, it cannot be claimed that any difficulty has been experienced with the lubrication of the parts, even when applied in the ordinary way.

The effect of super-heated steam on the indicator diagrams is worthy of notice. Steam being used as a perfect gas, the diagram approaches more nearly the theoretical, and, as there can be no re-evaporation in the cylinder, there is no tendency of the pressure to rise during the stroke, and the amount of work done in the low-pressure cylinder is brought down to the proper point.

(The foregoing is an abstract of a paper read before the Engine Builders' Association December 2d, 1902.)

Armature Displacement.

The Cause and Effect.

One of the most prolific sources of trouble in an electric generator, or motor, is the sagging out of centre of the revolving parts. Of course there are many other troubles, but this particular thing is so apt to occur in places where the shaft is somewhat worn that it is always well to ascertain just how true to centre it is before looking elsewhere for the trouble. What is true of the shaft getting out of place is true of several other things that are liable to become displaced. For the present it will suffice that we investigate what effect the displacement of the shaft can have.

Fig. 1 illustrates an armature of a two-pole machine which is out of centre in one direction, and Fig. 2 shows another two-pole armature out of centre in a direction at right angles to that shown in the first figure. The condition shown in Fig. 1 could be produced by a heavy armature running in rather light bearings for several years, and the side displacement of Fig. 2 could be produced by the tension of an extra tight belt. The mechanical effect of both these conditions would be to increase the pressure on the bearings, as the part a of the armature would be drawn toward the poles of the field with greater force than the opposite side. The

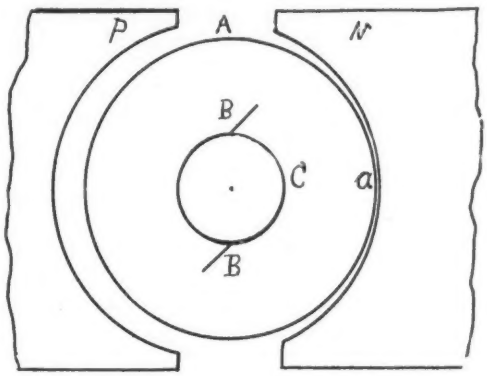


Fig. 1

downward pull, due to the attraction of the magnetism, would be greater in Fig. 1 than the side pull in Fig. 2, supposing both armatures and fields to be the same in both cases, and the displacements of the shafts equal. This difference is due to the fact that in Fig. 1 the magnetism of both poles is concentrated at the lower corners on account of this shorter air gap; hence both sides pull much harder on the lower side. In Fig. 2 the pull of the N pole is greater than that of the other, simply because in the latter the magnetism is more dispersed, but the difference in the density on the two sides will not be very great. If the bearings of a machine with the armature displaced, as indicated, have shown any signs of cutting, or if they run unusually warm, their condition will be improved by putting in new bearings that will bring the shaft central.

If the armature is of the drum type, the displacement of the shaft will have no effect upon it electrically. This is owing to the fact that all the armature coils are wound from one side of the core to the other, and, therefore, at all times, every coil has one side under the influence of one pole and the other side under the influence of the opposite pole, and if one side is acted upon strongly by one pole, it will be acted upon feebly by the other. If the armature is of the ring type, then the displacement of the shaft will effect it electrically, for in a ring armature the coils on one side are acted upon by the pole on that side only, and as the magnetic field from one pole will be stronger than that from the other (that is, considering the action upon equal halves of the armature), the voltage developed in the coils on one side of the armature will be greater than that developed on the other side. In Fig. 1, if the brushes bb could be placed on

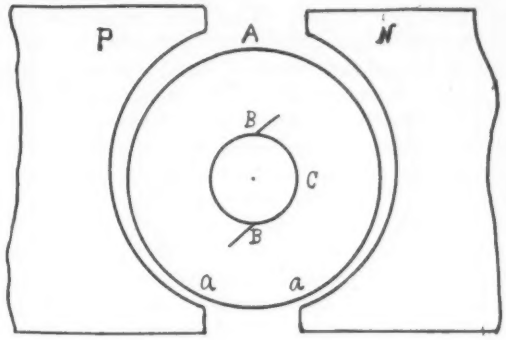


Fig. 2

the vertical diameter, as shown, the electrical action would not be interfered with, for on each side of the vertical line the magnetic action would be the same. But the reaction of the magnetism developed by the armature current twists the magnetism around, so that the brushes have to be rotated around some distance from the vertical line, therefore, even in the case of Fig. 1 the electrical balance will be disturbed if the armature is of the ring type.

The effect of the disturbance of the electrical balance will be that the brushes will spark badly, because the voltage of the current generated on one side of the armature will be

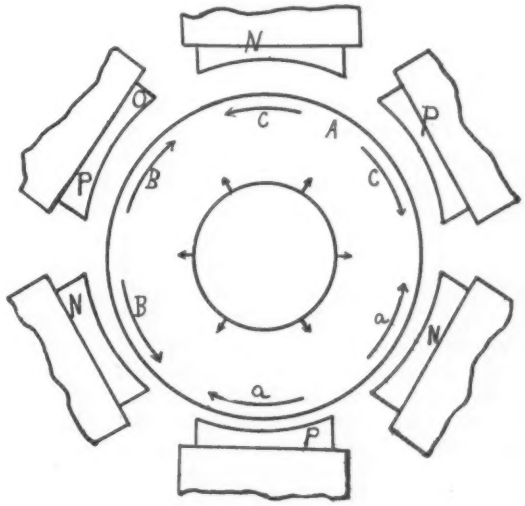


Fig. 3

greater than that of the current on the other side. Hence, when these two currents meet at the brushes, the strong one will tend to drive the weak one backward. If, while the armature is out of centre, we wish to adjust the brushes so as to get rid of the excessive sparking, all we have to do is to set them to the right of the center line, as in Fig. 2, so that the wire on the left side will cover a greater portion of the circumference than the right; or, what is the same thing, so

there will be more commutator segments between the brushes on the left side than on the right. In this way the voltages of the two armature currents can be equalized and the sparking can be reduced to the normal amount, or nearly so.

In a multipolar machine, the displacement of the armature will have the same effect mechanically as in the two-pole type; that is, it will increase the pressure on the bearings and probably cause them to cut, or at least to run warmer than they should. The effect produced upon the electrical action will depend upon the way in which the armature is wound; or, more properly speaking, upon the way in which the armature coils are connected with each other and with the commutator segments. As was explained in articles on construction of electrical machines, multipolar armatures are connected in two different ways, one of which is called the wave or series winding, and the other the lap or parallel winding. In the first-named type of winding the ends of all coils on the armature are connected with each other and with the commutator segments in such a manner that there are only two paths through the wire for the current; therefore these two armature currents pass under all the poles and the voltage of each current is the combined effect of all the poles. From this very fact it can be clearly seen that it makes no difference what the distance between the several poles and armature may be, for if some are nearer than the others, the only effect will be that these poles will not dvelop their share of the total voltage, but whatever their action may be, it will be the same on the coils in both circuits.

When a multipolar armature is connected so as to form a parallel or lap winding, then the connections between the coil ends, and between these ends and the commutator segments, are such that as many paths are provided for the current as there are poles, and each one of these paths is located under one pole, and as a consequence the voltage developed in it is proportional to the action of this pole. The diagram 3 illustrates a six-pole armature with the ends of the filed poles, and the arrows aa, bb, cc, indicate the six separate divisions of the coils in which the branch currents are developed. Now, it can be clearly seen that as the armature is nearer to the lower poles than to any of the others, the action of these will be the strongest. Hence, the currents aa will be stronger than the others and will have a higher voltage. These two currents will be taken off the commutator by the brushes at the lower corners. These same brushes also take off the currents developed by the action of the side poles, and which are indicated by the side arrows b c. These last two currents will be weaker and of lower voltage than the aa currents, hence the latter will try to crowd them back, and thus sparks will be produced at these brushes.

The two upper currents are weaker than the side ones, and their voltage is also lower, so that the current returning to the commutator through the brushes at the upper corners will not divide equally, but the larger portion will be drawn into the coils on the side and, as the upper coils will have to fight to hold their own, so to speak, there will be a disturbance of the balance that is required for smooth running. The result will be heavy sparking at these brushes. If these four brushes were shifted downward, the lower ones being moved more than the upper ones, points could be found where the sparking would disappear. This readjustment of the brushes would be the same thing, for a multipolar machine, as the shifting to one side, as explained in connection with the action of a two-pole ring-wound armature. Multipolar machines, however, are seldom made so that the brushes can be moved individually, so we cannot count on correcting the trouble temporarily in this way. In the great majority of cases, if the brushes of a multipolar machine spark on account of the armature being out of centre, the only cure is to reset the bearings, if they are adjustable, and if they are not, to put in new ones.

In the two-pole machines we have seen that if the armature is of the drum type, the action of the brushes will not be affected by the displacement of the shaft, and this will also be the case in a multipolar machine if the armature is wave or series wound. From this it will be inferred that there is a similarity between the two-pole drum winding and the multipolar wave winding, and such is really the case. The multipolar lap winding is the counterpart of the two-pole ring winding, and, in fact, a ring-wound armature will work perfectly in a machine with any number of poles, provided we place upon the commutator as many brushes as there are poles. If we made a ring armature and provided a number of different fields into which it would fit properly, one being two-pole, one four-pole, one six-pole, one eight-pole, and the others of greater number of poles; then, if each machine had as many brushes as poles, and these were set in the proper position, the armature would run as well in one as in the other, without requiring any changes in the connections between the armature cells and the commutator. In fact, all we would have to do would be to remove it from one machine and place it on the other, and it would be ready to run.

The regular ring winding is not used very often for multipolar machines, owing to the fact that the coils have to be wound in place, and on that account are not so mechanical in appearance, and are more expensive to make. The former coils are used almost universally for multipolar armatures, have both sides on the outer surface of the core, and on that account, when they are connected into a lap, or wave winding, they will not operate perfectly with a number of poles different from that for which they are connected, but they will run, although imperfectly, with any number of poles. From this it will be seen that if we have two generators of four and six-pole respectively, both using armatures of the same diameter, and both lap wound, if one armature gives out we can use the armature of the other machine as a makeshift; but it will not give as good results as in its own field. An armature with a wave winding cannot be used except with a field of the number of poles for which it is wound.

As sometimes it may be advantageous to change an armature from one machine to another while repairs are being made, provided the dimensions of the machine are the same, it is desirable to know how to determine whether the winding is wave or lap connected. You cannot tell from the general appearance of the armature, because both are wound with formed coils, but if we examine the two ends of the armature, we will find that with the lap winding the coils bend toward the same side after leaving the grooves, while with the wave winding they bend in opposite directions. To make this clearer, suppose we are standing at the side of the machine so we can see both ends of the armature; if the coils on the commutator end bend down toward the floor, the ends will bend up toward the ceiling at the pulley end, if the connection is wave, and they will bend down, the same as at the commutator end, if the connection is lap. Sometimes the ends of the coil at the pulley end of the armature cannot be seen, but in such cases we can determine the type of connection if we can find out whether the con-

nections from the coils to the commutator run in the same direction as the coils, or opposite to it. If the connections and the coil ends run in the same direction, the connection is for lap winding, and if they run in opposite directions, the connection is for wave winding. If there are only two sets of brushes on the commutator, the armature is wave wound. If the armature is wave wound and there are as many brushes as poles, we will be able to remove all but two sets without making any material difference in the running of the machine; but if the armature is lap wound, it will not run without the proper number of brushes. If a set of brushes is removed while the machine is in operation, a heavy flash will be produced with a lap winding, but with the wave winding there will only be a moderately large spark. Thus it will be seen that there are several ways in which we can determine the type of winding.

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The Principles of Dynamo Design

By T. H. REARDON

While it is not expected that every engineer in charge of electrical machinery will take the pains to become familiar with the principles of design, yet the principles underlying the construction of direct current constant potential dynamos are not difficult to understand, and when once thoroughly understood most anything that requires explanation in the operation of a dynamo will be understood also.

In the nomenclature of electrical engineering, the quantity of magnetism circulating in a magnetic circuit is known as magnetic flux, or magnetic density; it is the quotient of the magneto-motive force (which means a certain number of ampere turns), by the magnetic resistance or reluctance of the iron and air paith, both of which form the complete magnetic circuit.

The magnetic density is usually expressed as so many lines of magnetism per square inch of cross section; for example, in a bar of soft iron one inch square we may say that there are 90,000 lines of magnetism flowing; similarly in the core of the field of a bi-polar dynamo we may say that there are 90,000 lines per square inch, and then, if the cross section of the core equals 20 square inches, we have $90{,}000 \times 20 =$ 1,800,000 lines of magnetism as the total magnetic flux in the magnet core; it is proper to remark here that this quantity of magnetism that actually circulates in the magnet core does not all pass through the armature; usually about 75 per cent. of it passes through the armature core to the opposite magnet pole, and the amount that so passes is useful in generating E. M. F.; the other 25 per cent. is without useful effect, and at the same time those leakage lines of magnetism, in following stray paths in returning to the opposite end of the core from which they emanate, pass through the neutral part of the field and give rise to sparking and other disturbances. It is therefore important in the design of a dynamo to make this leakage of magnetism as small as possible, and this is accomplished by having the distances between the opposite pole pieces in a bi-polar dynamo equal to about 15 per cent. of the armature circumference. This will leave 70 per cent. of the wire in the active field, as magnetism leaks from sharp projections, corners, etc., the horns of the pole pieces should be neatly rounded off, and all sharp edges avoided as far as possible.

By definition an E. M. F. of 1 volt is generated when 100,000,000 lines of magnetism are cut in one second. Returning to the instance cited, in which we had 1,800,000 lines of magnetism in the field core and 75 per cent. of this passing through the armature core (that is, useful), we have 1,350,000 lines of magnetism for the generation of electro-motive force. The E. M. F. generated, if we have 100 wires on the surface of the armature, and a speed of 50 revolutions per second, will be $\frac{1{,}350{,}000 \times 50 \times 100}{100{,}000{,}000}$ equals 67.5 volts. The result should be understood without any difficulty. 1,350,000 lines pass through the armature; one wire would cut this number in a revolution, and, as there are 50 revolutions in one second, the total number of lines are cut 50 times in one second; furthermore, as there are 100 wires on the surface of the armature, the lines are cut 100 times as often as if there were but one wire.

It will be seen that the E. M. F. is the product of three factors, viz., field strength, speed and the number of wires on the surface of the armature.

Another matter will appear on inspection. The lines are cut twice in each revolution, instead of once, as shown in the calculation. The reason that this is not taken into account is that in the ordinary drum armature the two halves of the armature winding are in multiple with each other, and each half furnishes the full voltage of the dynamo, but only one-half of the amperage. In the example given twice the voltage stated is generated, but the two currents of equal potential are delivered to the positive brush, just as two dynamos generating 100 volts each would deliver their output to a bus bar, in which case we would have the sum of the amperes, but not the sum of the volts.

In the matter of designing a dynamo for a particular purpose, the armature is designed first, and the field is adapted to the armature; about the first thing to decide upon is the size of wire that will carry the amperes that the machine is to furnish, remembering that the two halves of the winding are in multiple, which gives twice the conductivity that would be had under opposite conditions, it is usual to allow about 600 circular mils. of cross section of wire per ampere. But, apart from the matter of a wire sufficiently large to carry the current without excessive heating, the wire size should be as large as practical considerations will allow. So that the armature resistance will be low and that the drop in the armature at full load will be small, a well-designed dynamo should not have more than 2 per cent. drop of potential in the armature at full load. But, as the first cost of a machine is frequently the first thing that is looked at, efficiency is often disregarded, when it might be secured at a small additional outlay. After the size of wire is selected, the speed at which it is desired to run the machine may be considered. The higher the speed the fewer the wires will be required on the surface of the armature, or the field strength may be less. The general tendency at present is towards lower speed and stronger fields. As a guide in commencing the design of an armature, it may be assumed that each foot of wire on the surface of the armature will generate an E. M. F. of 1 volt, with the speed and magnetic density within limits that are e asily reached. The calculation of an armature is best explained by means of an example. We will suppose that we have an armature with 200 wires on its surface, and the speed is to be 1,500 r.p.m., and we wish to generate 100 volts; 1,500 r.p.m. is equal to 25 r. per second; then the number of lines of force that must be cut per second; for the generation of 100 volts is $100{,}000{,}000 \times 100$ $= 10{,}000{,}000{,}000$, and the number of lines that must pass through the armature core is $\frac{10{,}000{,}000{,}000}{200 \times 25} = 2{,}000{,}000$, and if we allow a density of 60,000 lines per square inch in the armature core, the core must have a cross section of $\frac{2{,}000{,}000}{60{,}000} = 33.33$ square inches. The particular style of the armature is not important; it may be long and of small diameter, or short and of larger diameter; but in any case the

cross section perpendicular to the direction taken by the lines of magnetism should not be less than 33.33 square inches. The shape of the pole pieces will, of course, depend on the length and diameter of the armature.

The next thing is to calculate and design a field with the proper cross section of iron, and with sufficient space for winding the coils that are to send 2,000,000 lines of force through the armature core. As the magnetism that passes through the armature is only 75 per cent. of the magnetism that circulates in the field cores, the cross section of the field cores should be $\frac{33.33}{.75} = 44.44$ square inches, and the cross section of the yoke may be even greater in the above example, it is not necessary to make this extra allowance for the cross section of the field cores, as density of 90,000 lines per square inch is not unusual in the magnet cores of dynamos.

To calculate the ampere turns necessary to force the required amount of magnetism through the magnetic circuit, first take the air gaps between the pole pieces and the iron of the armature core, measure this distance, and add the length of the two air gaps together, and express this length of air path as a fraction of an inch (usually it will be less than one inch). Next, from the total number of lines of force entering the armature calculate the number of lines that are concentrated in one square inch of cross section in their passage through the air gap, and call this H. Let L represent the length of the air path, both gaps added and expressed as a fraction of an inch; then the ampere turns necessary to force the magnetism through this portion of the circuit is given by the formula: A. T. $= \frac{H \times L}{.192}$ is ampere turns required for the air portion of the magnetic circuit are very much greater than for the iron portion of the circuit. The ampere turns required to drive the magnetism through the different portions of the iron circuit is calculated in the same manner. For instance, in our armature, supposing the length of the magnetic path through it to be 4 inches and the density per square inch 60,000 lines, by referring to a table of magnetic permeability we would find that, with soft wrought iron and a density of 60,000 lines per square inch, about 12 ampere turns per inch of length are required; similarly for the magnetic path through the field it may be 50 inches in length and the density may be 90,000 lines per square inch of cross section; the ampere turns required at this higher density are about 50 per inch, and the number required are $50 \times 50 = 2{,}500$. When the ampere turns are found in this manner for each portion of the circuit, the numbers so found are all added, which gives the total number required for the field. It now only remains to select the proper size of wire for the winding, and this matter requires some care; if too large a wire is chosen, the field will get enough ampere turns, but the large current that will circulate will be productive of much heat, as well as wasteful of energy; of course the current taken by the field can be regulated by a resistance, but with a careful design the amount of resistance used for this purpose can be made very small—just enough for purposes of regulation. On the other hand, if too small a wire is chosen, the field will not take sufficient current from the brushes to produce the necessary magnetism; the only remedy in this case is to increase the speed.

The ampere turns can be made up in any convenient way, one turn of wire, with 5 amperes flowing, or 5 turns of wire, with 1 ampere flowing, are equal to each other in magnetizing effect.

The writer has used the formulas given here in the design of five different dynamos, the machines ranging in capacity from 10 to 100 lamps each, and the results in every case were highly satisfactory. The designs were for speeds ranging from 800 to 3,000 r.p.m., and for voltages from 52 to 100.

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Steam Engine Design.

By A. EDWARD RHODES.

Part II.

Valve.—The proportions of a slide valve are determined by the size of the ports. The exhaust port must always be wide enough so that when the valve is at the end of its travel the width of exhaust port remaining open is at least equal to the width of the steam port.

Let a = width of exhaust port.
b = width of steam port.
c = width of bridge, usually same as cylinder walls.
k = half of valve travel.
i = inside lap.
o = outside lap.

Then in Fig. 1 $h = a + 2(c - i)$.

$e = b + i + o$.

$l = a + 2c + 2b + 2 \times o$.

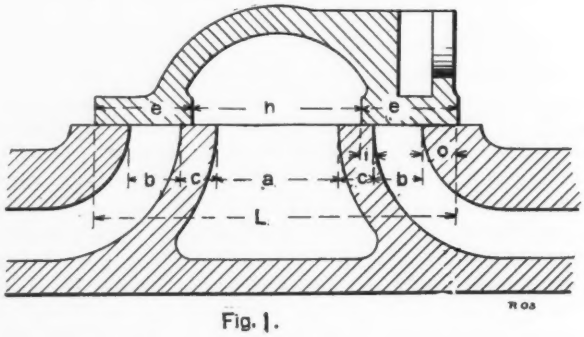

Fig. 1.

When the valve at the end of its travel just opens the steam port fully

$k = b + o$.

Piston.—The thickness of a piston may be 4-10 of its diameter, and have two or more packing rings. For our 12-inch engine the piston would be $.4 \times 12 = 4.8$, or say $4\frac{3}{4}$ inches thick.

Piston Rod.—The piston rod, if of steel, may have a diameter of one-fifth of the bore of the cylinder for pressures up to 125 pounds per square inch, or $12 \div 5 = 2.4$, or, say, $2\frac{1}{2}$ inches, for our 12-inch engine.

Connecting Rod.—Length may be 2 to $2\frac{1}{2}$ times the stroke.

Diameter at small ends = D × 2-10.

Diameter in middle = D × .25.

Area of straps = area of smallest part of rod.

Distance of key-way from edge of butt = $\frac{1}{2}$ of diameter of crank-pin.

Depth of gib at centre = 2-10 of diameter of crank-pin.

Depth of key at centre = 2-10 of diameter of crank-pin.

Crank Shaft.—The diameter may be one-half of bore of the cylinders for engines less than 14 inches bore. Then, for our 12-inch engine the crank shaft diameter is 6 inches.

Crank Pin.—In modern practice the crank-pins are made larger than strength alone requires, and quite frequently you will find the crank pin having the same diameter as its shaft.

For steam pressures of 75 to 100 pounds per square inch, a rule that is sometimes used is to make the diameter

.27 × D. Then .27 × 12 = 3.24, or 3¼ inches for a 12-inch bore. Remember that this last rule is for low-pressure, and should not be used if engine may at any time be subjected to a greater pressure or to a very high rotative speed.

The Crank (A, Fig. 2).—The important dimensions may be:

D = bore of cylinder.

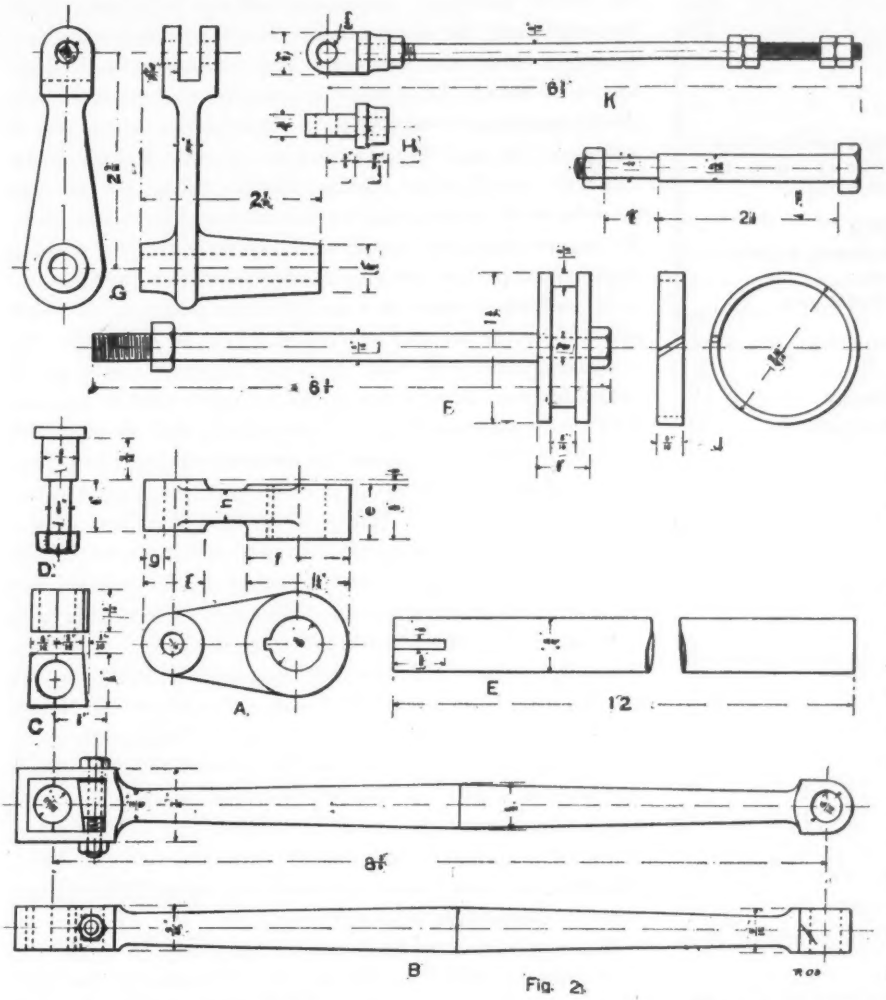

Fig. 2.

d = diameter of crank-shaft.

e = d + 1 inch.

f = 2d.

g = same thickness of metal as at F.

h = .75E.

Description of Details of half horse-power engine.—Refer to Fig. 2.

The Crank (A).—The crank is cast iron. The large end is driven on the end of the crank-shaft, and as a further means of preventing its turning thereon a ⅛ of an inch square key is fitted and driven in. It is less work, and for so small an engine as this, possibly as good, to drill a ⅛ of an inch hole half in the shaft and half in the crank, and drive into it a round piece of iron. Great care should be taken to have the shaft hole and the crank pin hole parallel when finished.

Connecting Rod (B).—The connecting rod is made of wrought iron, with a wedge adjustable brass-bearing C at the crank end. The wedge is adjusted by a 3-16 of an inch diameter screw.

Crank Pin (D).—The crank pin should be carefully fitted and driven into the crank, then fastened by a ¼ of an inch nut. The crank pin is made of wrought iron.

Crank Shaft (E).—The crank shaft may be simply a pin of cold rolled shafting, ⅝x12 inches, and having a key-seat in it to fit the crank.

Piston and Rod (F).—The piston is of cast iron turned to fit the cylinder, and has a groove turned in its periphery to receive the ring.

The rod is of steel, 5-16 of an inch diameter, with one end reduced in diameter to fit the bore of the piston. It has a thread at each end, one to fit the cross-head and the other for securing the piston to the rod. Make piston a driving fit on the rod.

Piston Ring (J).—This ring is made of steel turned to 1 13-16 inches diameter, is 3-32 of an inch thick and 5-16 of an inch wide. Split and cut away enough to make it fit the cylinder steam tight.

Rocker Arm (G).—The rocker arm is of cast iron. It is fulcrumed to the main frame by the bolt c.

Rocker Arm Bolt (c).—This bolt is finished to the sizes marked on it, care being taken that its small diameter is a tight or driving fit in the main frame.

Valve Stem (K) and Fitting (H).—The valve stem is connected to the eccentric rod (shown next month) by the rocker arm (G) and a brass fitting (H), which is finished all over.

The valve stem is 3-16 of an inch diameter, has four brass nuts and a thread 2⅛ inches long at the steam chest end for holding the valve. At the other end the thread is about ½ of an inch long for screwing into the brass fitting and for adjusting the valve. The valve can also be adjusted by the four brass nuts.

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Owing to the trouble caused by soft coal clogging pipes and chimney flues, the following suggestion is worthy of noting: "Zinc is a peculiar metal in many respects. It volatizes easily, and the oxide thus produced has a strong affinity for carbon. If one's surface chimney is clogged up with soot, and the owner desires to get rid of it, all that is necessary is to throw a little zinc scrap into the fire. Any old zinc will do, and very little will suffice to keep the chimney clean if used about once a week. The vapor of zinc oxide seizes upon the carbon of the soot and forms a new chemical compound, part of which goes up the flue and part falls to the bottom to be shoveled out as ash."

The Practical Engineer

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The Value of Hydraulic Tests

The subject of making boiler-strength tests by means of the hydraulic method is worth considerable thought. This system is used so universally that anyone disputing its value is looked upon somewhat in the light of a heretic. Yet there is room for doubt concerning the value of the hydraulic test. Boiler manufacturers recognize this fact, and so do the inspectors, but the ease of application usually gives the hydraulic system precedence.

We know that even if a boiler has been carefully designed and the workmanship and every detail inspected, the safety can only be determined by the application of pressure. If every piece of metal has been tested and the parts put together according to the best results of long experience, there may be defects, such as bad welding, careless riveting, or plates cracked in flanging, which will impair the strength of the boiler.

There are certain classes of boilers so constructed that it is almost impossible to inspect them from within, of which the locomotive, crane and small agricultural boilers are examples.

Many hidden defects are brought to light by careful inspection and the pressure test.

There are two ways of applying the pressure test—by steam and by water. In testing by steam, the conditions of strain are the same as those under which the boiler is worked. But the practice of testing a boiler with twice the steam pressure that is required is likely to weaken, if not explode, it.

One method of testing is to pump water into the boiler until the desired pressure is reached. The distortions or defects of joints are then noticed. In testing a new boiler the various parts should be carefully measured and gauged, and the results recorded. After the test has been maintained for some time, the measurements should be taken again and compared with the original. Any extension or bulging should be noted. On release of pressure, the measurements should be taken a third time to find the permanent set of any part. In case of permanent set, the material should be carefully tested, to see whether the permanent set was due to defects of construction or to an exceeded elastic limit. There are instances, stayed surfaces for example, when a slight permanent set does not render the boiler unfit for use.

If the boiler leaks under the hydraulic pressure, the leaky joints should be marked and calked when the pressure is off.

Another method is to fill the boiler with water, close every outlet and then build a fire in the furnace. Water expands 1-24 of its volume when the temperature rises from 60° F. to 212° F. When the water in the boiler is heated there is a corresponding increase of internal pressure, and the condition of the boiler is judged from the movement of the pointer of the pressure gauge. Steady rise of pressure indicates soundness, while jerks or starts of the pointer are considered to denote weakness. This method is seldom used because of the difficulty of regulating the fire so as to give a steady increase of heat and of keeping that heat constant for any length of time. Although no explosion can result from hydraulic tests, a serious accident can happen when the plates fracture. Many say that the hydraulic test is worthless because it does not show the actual strength. The most injurious stresses, those due to unequal expansion, are not set up during this test. In order to find out the exact strength, the boiler must be destroyed, or at least so fractured or strained as to become worthless.

The application of high pressure is likely to strain the boiler and to render it unfit for the intended low pressure.

A boiler that has been at work for some time is considered safe if it will stand the test of a pressure one and a half times the working pressure.

The inspection of a boiler should commence at the works where the plates are manufactured. If the material and each detail of construction is inspected and tested, the boiler is likely to be strong.

The other test, the efficiency test, is of importance to boiler owners in order that they may know the boiler from the economic standpoint.

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Where the Engineer's Duty Lies

It is an old and well-established truth that "if you want anything well done you must do it yourself." This applies to the boiler room just as well as it does to the engine room. Nearly all engineers keep their engines and engine rooms in good shape. This is as it should be, but do not spend all your time and energy in the engine room.

Remember, there is a just distinction between the production of steam and the application of steam. No matter how economical the application may be if the production is not the most economical practicable you are not securing the best practical results. Do not be satisfied with a knowledge of the engine horse power only, but see to it that you know all about the boiler horse power.

It should be remembered that even if you do tell the fireman to clean the flues, yet that is not a criterion that they will be cleaned.

An engineer should see that the boilers are kept clean both inside and outside and that the firemen make intelligent use of the flue damper to each boiler.

An economical engine may give you quite satisfactory results as to cost per horse power developed at the engine, or as indicated electrically, when the cost of production per boiler horse power, i. e., 30 pounds of water evaporated from 100° F. to steam at 70 pounds gauge pressure, is not as economical as it might be. Begin at the furnace and know the coal is burned in the most economical manner, then examine the boilers frequently and thoroughly and know the heat made by the furnace is applied in the most efficient manner to the heating surface of the boiler and the boiler heating surface is in proper condition to absorb the heat and that the steam pipe is of proper proportion. In this way you will insure the best economy in the production of the steam furnished to the engine.

If this method be pursued by the engineer he will find that as each year rolls around the percentage saved will greatly exceed that of the brass-polishing method in the engine room—which, by the way, is very commendable when it does not retard the aforesaid work.

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An Ideal Chief Engineer

While we are constantly hearing of strikes and lockouts, and of the ever-crushing hand of the trusts, we seldom hear of a case where a large corporation voluntarily submits to their men a proposal to shorten their hours of labor, and that without material reduction in wages. Yet we are pleased to record such a procedure by the Atlas Portland Cement Works, at Northampton, Pa., which is the largest cement works in America, its present output being 10,000 barrels daily.

The concern employs about eighty engineers, who come directly under the control of Chief Engineer H. T. Raisbeck. Mr. Raisbeck is a man who demands strict attention to duty by his men at all times, and will permit no infraction of the rules, yet it is directly to his efforts that the company made this most radical and, we may add, sensible, departure from all precedent, in voluntarily reducing the working hours of their engineers, firemen and electricians from a twelve to an eight-hour day. This action was taken by the company without a single complaint from the men, it being the belief of both the chief engineer and Superintendent Seaman, who are both broad-gauged men, that in order to obtain the most efficient service from men in responsible positions they should have ample time for rest and study, thereby enabling them to be keen and alert and always capable of exerting themselves to the limit should occasion require special effort. In this way it is believed the men will render as valuable service to the company in eight hours as they would in twelve under the former exhausting conditions. For the sake of our profession and of all working men we hope and fully believe they will not be disappointed.

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The American People and the Millionaire Philanthropist

During the past few months we have seen in blazoned headlines where this or that prominent millionaire has given a donation to some college or library which in its munificence for the moment makes the donor appear in a light worthy the commendation of all men. No doubt we have all heard of the man who went to church and borrowed a quarter from a friend (which he never paid back) to place in the collection box. And it requires no Solomon to guess who really did contribute the quarter, despite appearances.

Now let us digress a little and analyze some of the latest presents which " the people " have received from one or two of our richest men. Mr. Rockefeller has recently given to the University of Chicago $1,000,000. But, immediately following this burst of munificence, he raises the price of oil to an extent which will increase his income five times annually over the amount of his donation; thus it must be recognized that the Rockefeller endowment fund is really made up of a compulsory popular subscription.

Again, let us look over the many gifts which Mr. Carnegie has bestowed upon our municipalities, and we find that the amount reaches a number of millions yearly. But, if we push aside the curtain of glamor surrounding his gifts, and look at his income and its source, we find that for every million given away he has levied upon the pockets of the public threefold by increasing the price of the output of his factories.

To some it might appear that the variation in price of iron would not affect the masses, but therein they are wrong, for if the railroads, the builders and others, have to pay higher for their material they hasten to recoup themselves from the public.

Of course they might keep their millions altogether, as many do, but the method of giving one million ostentatiously and demanding two in return indirectly seems to be a very efficacious manner of quieting any clamor the people might be disposed to make.

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While the editor of The Practical Engineer was enjoying a shave in a barber shop around the corner the other day he overheard an interesting dialogue between a clever barber at the adjoining chair and his " victim," who turned out to be the keeper of a near-by groggery, with a very limited knowledge of things mechanical, or otherwise, but with a penchant for asking all sorts of question. In this case he looked up drowsily at the incandescent lamps above and said: " Are thim lights thirty-two horse power? " " No," said the barber; " they are twenty-five degrees."

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

More About the Syphon

Editor THE PRACTICAL ENGINEER :

Some time ago, in your "Letters from Engineers," you published some articles on the working principle of the syphon. Looking up one of these articles lately, I was struck by the conspicuous absence of an important part of the theory, viz., the cause of the continual flow of water from the long leg. We know that the atmosphere will support a column of water 34 feet high, yet here, if the long, or discharge, leg is only 10 feet high, the pressure of the atmosphere cannot support the column of water inside.

This I would like to try to explain. Every engineer knows that the atmosphere above the earth exerts a pressure on its surface of nearly 15 pounds per square inch, due to its weight; so that if a vessel of water is placed with its surface open to the atmosphere, every square inch will sustain a pressure of 15 pounds.

According to the laws of hydrostatics, this pressure is transmitted undiminished in all directions, hence, if a pipe open at both ends be placed vertically, with one end in the water, the pressure will be transmitted up the pipe; but, as the pressure downwards in the pipe is the same, the water will retain its old level. This shows the same principle as that on which a pair of scales works, except that the water has a kind of universal fulcrum.

If the pipe alluded to be closed at its upper end, and the pressure within reduced to 10 pounds per square inch; then, if the pipe had a cross section of 1 square inch, 5 pounds of water would rise in the tube, so as to make the pressure or weight above the general level of the water 15 pounds both outside and inside the tube. This would have to occur before the columns were in equilibrium.

The syphon consists merely of a tube open at both ends and bent so as to form two legs at any angle less than 180°. One leg is placed in a vessel of water and the other outside. The height of the bend must, of course, be less than 34 feet. The length of the legs is of no consequence, but the opening of discharge leg must be below the level of the water in the vessel to be emptied. The reason for this will be seen later. The syphon is started by extracting the air from it, or by filling it with water, which, of course, ejects the air; then, placing one end in the water and the other end outside and lower than the water level.

Now, in a practical case we see that the water is discharged from the lower end until the levels are equal, or the upper vessel is emptied. The reason is this:

Suppose, for the sake of simplicity, the tube has an inside cross section of 1 square inch, and the bend of the tube is $11\frac{1}{2}$ feet above the water. The downward pressure of a column of water of these dimensions is 5 pounds. The pressure upwards at the base of the tube is 15 pounds. Therefore, the pressure tending to force the water over the bend is $15 - 5 = 10$ pounds. Now, suppose the discharge leg is 14 feet long. A column of water of this height weighs about 6 pounds, and, added to this, the 10 pounds pressure over the bend $= 10 + 6 = 16$ pounds pressure tending to force the water from the opening in the discharge pipe. Opposed to this is the atmospheric pressure of 15 pounds. Obviously the water will flow in the direction of the greater force.

F. H. S.

Edmonton, Canada.

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"The Real Cause of Boiler Explosions"

Editor THE PRACTICAL ENGINEER :

In the January number of THE PRACTICAL ENGINEER I noticed an extract from an article on "The Real Cause of Boiler Explosions," in which it is alleged that boiler explosions are not a result of the strain caused by steam pressure, but only resulting from the explosion by combustion of gases said to have been "created" in the boiler by the excessive heat of the flues.

I concur with "An Engineer of Long Experience" in that hydrogen gas may be liberated (but not created) by passing steam over iron cuttings at high temperature, or some other element that has greater affinity for the oxygen of the water than has the hydrogen with which it is then in combination. Thus the oxygen leaves its hydrogen to combine with iron. But to think that any ignition of the free hydrogen (if any be present) takes place, I regard as a lame conclusion. In the first place, there is present no free oxygen to support combustion, and, granting that there is oxygen present to unite with the hydrogen in combustion, is it reasonable that the same conditions that forced them apart would force them back together? We grant again that it should, and they reunite; what have we then? Simply H_2O, the same thing with which we started.

Now, in view of the fact that as the power of resisting strain, either tensile, transverse or crushing, begins to decrease even before the temperature of the material of which the boiler is constructed reaches redness and continues to decrease as the temperature rises above that point, would it not be more reasonable to suppose that as the strain of steam pressure and the strength of the material of which the boiler is constructed are converging to a common point, that when this point be reached the boiler will rupture? In all probability he was correct in that it was due to low water. Many times water gauges are treacherous if not properly looked after, and the ordinary water-column gauge is not too accurate at its best. Low water would induce the conditions above referred to, but in my opinion the assertion that it is due only to 'ignition' is just as preposterous as the assertion that "steam never exploded in a boiler in the world."

Were this theory correct I should advise that those in charge of plants incorporating super-heating apparatus "cool down" and haul out the death-dealing machine as quickly as possible.

The best thing I see in the extract is that "fools rush in where angels fear to tread." I guess he invented that, too.

Now, an "Engineer of Long Experience" may be correct in his reasoning, and if he is I would like him to give me the formula for the chemical action that takes place in the boiler as it explodes. I warrant that it will be read with interest, for I know quite a number of engineers who are fairly intelligent fellows and enjoy good, wholesome reading matter, but they do not like to have just anything run down their throats without knowing what it is that they swallow. There is another class that would make better "hot-air" en-

gineers than steam engineers. I presume this class reads little and thinks less.

I think that a little logical reasoning along scientific lines would often be of value to us in forming more correct conclusions as to the real cause of many disasters, as well as to arrest, in a measure, the random theorizing which I regret to say is indulged in by many of the disciples of our chosen and honorable avocation. D. A. G.

[" D. A. G." has misinterpreted the cause of our placing in the editorial columns the article entitled the " Real Cause of Boiler Explosions." It was not our intention that anyone should accept the article other than as a demonstration of ignorance. The quotation, " Fools rush in where angels fear to tread," was a remark of our own, and was added with such an inflection of sarcasm that we thought all our readers would note at once the drift of the article, but our printers made the mistake of placing this sentence in small type with the body of the extract which we were attempting to ridicule.—EDITOR.]

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Banking Fires

Editor THE PRACTICAL ENGINEER :

I find much that interests me in your " Engineers' Letters " column, and will take the liberty of adding a little of my experience in the matter of banking fires, in hopes that it will interest, if not instruct, your readers.

Different engineers pursue different methods in banking their fires, but the usual style is to push back the fire one-third towards the bridge wall, and clear off the grate in front. Then shovel in 200 to 300 pounds of fine coal in a manner which will completely cover the live coals, closing the ash-pit doors and leaving the furnace doors open, with the damper open enough to let the gases escape. Sometimes this is varied by closing up all air holes and also the furnace doors and merely leaving the damper partially open. I find, however, that I can accomplish better results, both in holding the fire and in saving coal, by spreading the fire well over the grate; then cover thinly with fine coal. Following the coal, I cover the whole over with wet ashes, so that no flame can be seen; then close the ash-pit doors, leaving the furnace doors wide open; I partially open the dampers so that the gases may escape. In the morning I find my fire in a good condition and ready for work by raking off the ashes, which are usually caked so as to separate easily, and throwing on fresh coal. J. B.

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The Death of John Cork

Most of our local engineers, and many engineers from other cities, especially those who have been accustomed to attending conventions and other gatherings of national interest to stationary engineers, will undoubtedly learn with sincere regret of the death of Mr. John Cork, the genial Philadelphia representative of Jenkins Brothers. Mr. Cork passed away on December 27th, after an illness of but a few days. He was 36 years old, and had been with Jenkins Brothers for the past thirteen years, during which time he made hosts of engineer friends, to whom his pleasant smile and honest greeting will ever be a cherished memory. It has been said that men who " have no enemies " also " have no friends." But John Cork was a shining contradiction of this time-worn adage. With a heart which had no thought of quibbles and quarrels, he won his way into the affections of all with whom he came in contact. He was always well posted on matters concerning engineers and enjoyed a local reputation as a story teller of more than ordinary ability. To his employers the loss is greatest, and they speak of him with sincere affection. Everywhere we hear his engineer

JOHN CORK

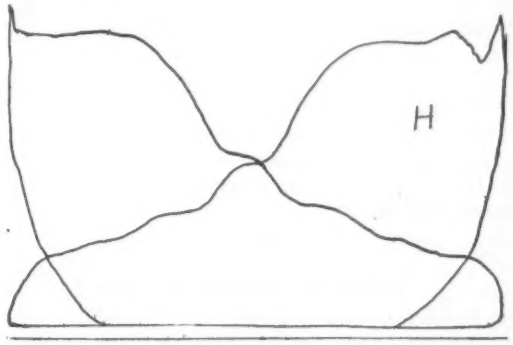
friends speak of his death with evident feelings of regret. The tribute is indeed as complete as it is well deserved, for his life was unobtrusive, but ever sincere.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

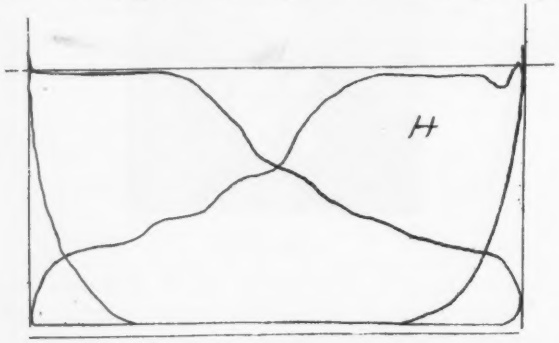
EDITOR PRACTICAL ENGINEER:

I am a regular reader of your journal, in which I find many items of great value to me. Now I would like some enlightenment on the enclosed diagrams, taken from a Buckeye engine, style C, 9½" by 14" by 246 revolutions; boiler pressure on one card 100 pounds, on the other 90 pounds. I used a 40 spring in both cases.



Now the cards were taken by the improved Robertson-Thompson indicator, which is nearly new. Those cards were taken within fifteen minutes of each other. The load was varying somewhat, as you will notice. You will also notice

particularly the initial pressure of the head end card much lower than the bed end. Why is this, and what is the cure? Also the same card right at the beginning of the stroke those saw teeth. I should like to know the cause of those and also the remedy. You will also notice on both cards the admission line shoots above the steam line and then drops below, and goes up once or twice before the stroke commences. Why is this? I have shifted the eccentric over and back so as to shorten and lengthen the head and compressions, and it does not do any good. In fact, I have tried everything that



I know of and failed to improve those cards any. The engine is of their ordinary automatic double-slide valve type. The engine has been running fourteen years, and now is just from the factory, where it was repaired and new piston and rod valves and seats redressed, and this is the result. I should like to have any criticism on the cards and the explanation in detail to correct the error, and oblige

J. W. Bearden.

[In the first place, you are using entirely too light a spring. If you will try a 60, you will see that much of your wavy line effect will disappear. In the matter of the pencil lines running up so high and then see-sawing, we would say that your compression is so much that it forces it above the normal. We may look for some of this in a high-speed engine always, but not so much as is shown on your head end. That of the bed end is about right. In the matter of the initial pressure of the head end being so much less than the other end, we feel safe in saying that you have a leak around the piston, or else your ports are very much obstructed, thus wire-drawing the steam; however it looks more like a leak. We would advise you to block your engine on center and try to find the leak. It might be simply that your drain cocks on that end have lost their seats; look that up, too. Change your compression. Try a heavier spring and see if you haven't overcome the trouble.—Editor.]

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The largest office building in the world is the Broad Exchange, on the southeast corner of Broad and Exchange Place, New York. It rises twenty stories high over 27,000 square feet of ground, and cost $7,500,000, although it has no ornamentation.

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Carrying Capacity of Pipes

Editor Practical Engineer:

Will you please give a table showing the carrying capacity of pipes, both of steam and water, under various pressures, and also a rule to find the amount of water handled by a pump at 100 feet piston speed per minute.

W. C. Pierce.

Table of Flow of Steam Through Pipes.

Initial Pressure by Guage. Pounds per Square Inch.	Diameter of Pipe in Inches. ¾	1	2	3	5	8
	Weight of Steam per minute in pounds, with one poun l loss of pressure due to friction.					
1	1.16	2.07	10.27	25.38	77.3	211.4
10	1.44	2.57	12.72	31.45	95.8	262.0
20	1.70	3.02	14.94	36.94	112.6	307.8
40	2.10	3.74	18.51	45.77	139.5	381.3
60	2.43	4.32	21.38	52.87	161.1	440.5
80	2.71	4.82	23.82	58.91	179.5	490.7
100	2.95	5.25	25.96	64.18	195.6	534.6
150	3.45	6.14	30.37	75.09	228.8	625.5

Gallons of Water Discharged Per Hour Through Various-sized Orifices under Stated Pressures.

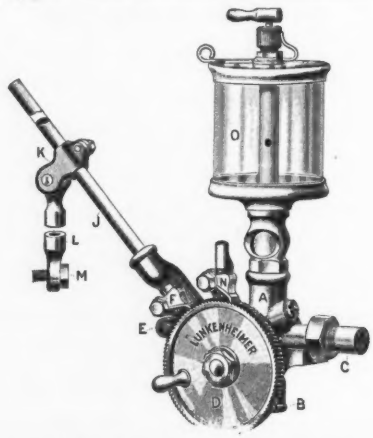
Head in Feet	Pounds Pressure per Square Inch	Diameters of Orifices in inches and fractions of inch. ¼ inch	½ inch	1 inch	2 inch
20	8.66	300	1260	4920	19740
40	17.32	450	1800	6720	27960
60	25.99	540	2160	8580	34260
80	34.65	620	2460	9840	39540
100	43.31	690	2760	11040	44280
120	51.98	780	3000	12120	48480
140	60.64	816	3300	13020	52320
150	64.97	840	3420	13560	54120
175	75.80	900	3660	14640	58560
200	86.63	960	3900	15600	62580
235	101.79	1080	4320	17100	68460

The capacity of any pump may be determined by multiplying the area of the piston in inches by its stroke in inches, giving the number of cubic inches per single stroke. This divided by 231 (the number of cubic inches in a standard gallon) will give the number of gallons per single stroke; but it must be remembered that all pumps throw less water than their capacity, the deficiency ranging from 20 to 40 per cent., according to the quality of the pump. This loss arises from the lift and fall of the valves, from inaccuracy of fit or leakage, and in many cases from there being too much space between the valves and piston or plunger. The higher the valves of any pump have to lift to give the necessary opening, the less efficient the pump will be.

✣ ✣ ✣

The Lunkenheimer Force Feed Lubricator

Engineers realize that to obtain positive results in lubrication it is necessary to use a mechanically-operated lubricator of the pump type. This method of lubrication is more reli-



able than that obtained by lubricators hydrostatically operated, and, when properly constructed, the oiling is positive,

and all of the oil fed to the pump is bound to be forced to the steam chest or cylinder of the engine.

The accompanying illustration shows a force feed oil cup manufactured by the Lunkenheimer Company, Cincinnati, Ohio. A study of the working parts will show simplicity of working parts and absolute certainty of operation. It will be seen that the driving mechanism is of the ratchet type, and is operated by the (F) and (N) that work co-operatively by the motion of the rod (J), which can be attached to the eccentric rod or other moving parts of the engine by the couplings (K) and (M). The motion thus obtained is transmitted to the piston by the crank pin mechanism.

The ratchet wheel is provided with a handle whereby it can be operated by hand in case it is desirable to force a quantity of oil at any time, as, for example, when starting the engine.

By moving the part (K) up or down the rod the stroke of the pump can be lengthened or shortened, as desired, thus regulating the amount of oil fed by the pump independent of the feed from the oil cup. The joints of the cup are tight, the sight-feed glass being packed so as to prevent the access of air that would have a tendency to cause the cup to feed after the engine had ceased running. This construction and the use of check valves in the pump prevent the oil supply from flooding.

The outlet (C) is piped to the steam pipe or chest of the engine, and the spring check valve (X) should be placed as near the end of the pipe as possible, preferably into the steam pipe.

The bottom of the pump body (B) is tapped $\frac{1}{2}$-inch pipe thread to receive a stand so that it can be placed wherever desired. The pump is substantially constructed, the workmanship being first class, and, as the parts are made to jigs and templets, they can all be easily renewed, being perfectly interchangeable.

The ratchet wheel (D) and pawls (F) and (N) are made of tool steel, tempered and hardened. All other metal parts about the pump are made of hard bronze composition.

✣ ✣ ✣

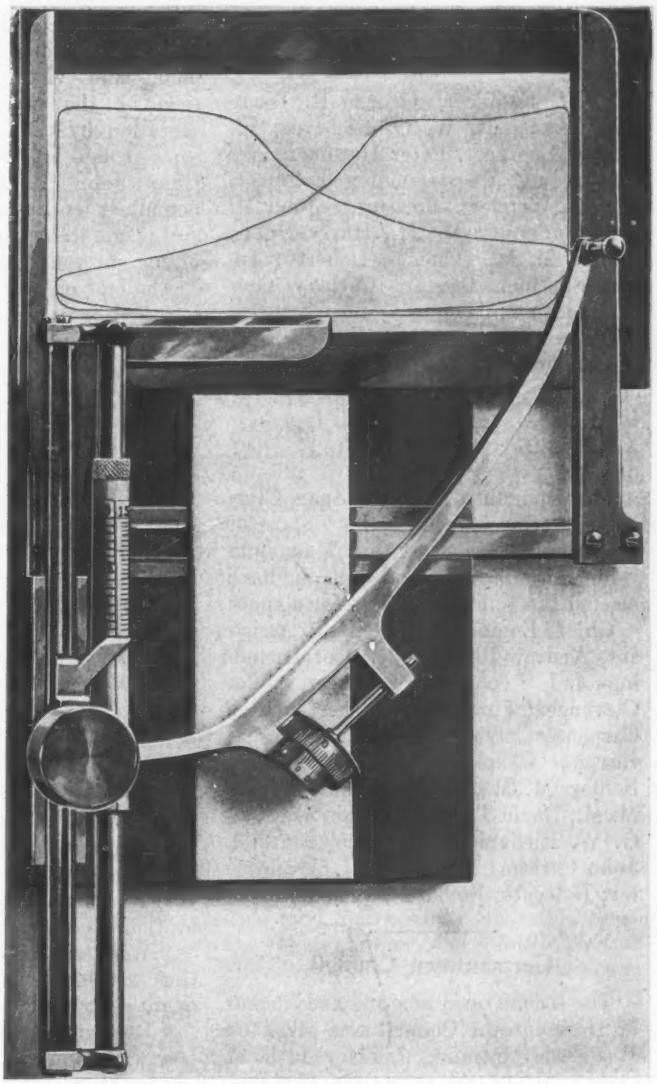
The Bushnell Improved Planimeter

No engineer using an indicator can afford to be without a planimeter. This valuable appliance simply accomplishes in a few moments a task otherwise requiring interminable figuring, and accomplishes it correctly, too.

The accompanying cut shows the Bushnell Improved Planimeter, for measuring indicator diagrams. Probably one of the strongest features of this appliance is that it is arranged so either the area or the mean effective pressure can be easily read direct from the instrument.

To those unfamiliar with the operation of the planimeter it may be well to say that to find the M. E. P. of a diagram, the card is placed upon the plate with the extremity of the diagram which is to be measured against the right-hand clip, as shown in the cut. The tracing point is placed upon the diagram in contact with the clip, the recording wheel set at zero, and the tracing point carried around the diagram clockwise. Upon its return to the starting point the tracer is carried upward along the edge of the clip until the wheel returns to zero. The distance between the starting point and the final position of the tracing point, measured upon the scale with which the diagram was taken, will be the mean effective pressure.

With the older form of the instrument it was necessary to mark the points of departure and finish, and measure the distance between them with a scale. The improvement consists in the mounting upon the instrument itself of a scale, as shown in the engraving, which may be adjusted longitudinally so that the pointer at the left-hand end of the planimeter arm will stand at zero at starting; and, since the vertical movement of this pointer is the same as that of the tracing point, the mean effective pressure may be read off directly upon this scale, the cylinder upon which the several scales are engraved being revolved by means of the milled head to bring the proper scale under the pointer. The position shown in the engraving is the initial position, with the tracing point against the right-hand clip at the extremity of



the diagram and both the wheel and the scale at zero.

We also note very ingenious arrangements for making the instrument compact for carrying, it being contained all complete in a morocco velvet-lined case 8″ by 4″ by $1\frac{1}{2}$″ outside measure. Each instrument is provided with six scales set upon a revolving scale holder, for reading M. E. P. and is so constructed that the scale holder can be removed easily and quickly replaced with another, bearing scales of other denominations, so that there is practically no limit to the number of scales which may be used.

More complete information as to this planimeter may be obtained from John S. Bushnell Company, 126 Liberty Street, New York, N. Y., who are the manufacturers.

Society News

American Order of Steam Engineers

Philadelphia Council, No. 7

The new officers of Philadelphia Council, No. 7, A. O. S. E., were installed on January 14th by First Assistant Grand Chief John J. Kelley, assisted by W. J. Eccles. They are as follows:

Chief Engineer, George R. Woolcock; Assistant, W. G. Richards; Financial Engineer, Peter Hardman; Recording and Corresponding Engineer, W. S. Wetzler; Treasurer, John M. Curry; Senior M. M., Harry Dunn; Junior M. M., Thomas Doherty; Inside Sentinel, Barnard Carbary; Outside Sentinel, Thomas Quinn; Trustee, Clarence Muncy; Chaplain, Robert L. McMasters; Delegate to Grand Council, Frank J. Cannon.

Manayunk

Corresponding Engineer John Clevenger, better known as the "State of Manayunk," writes us that Manayunk Council is still living and well, and have elected the following rulers for a time:

Chief Engineer, John Hill; Assistant, Andrew Roberts, Jr.; Corresponding and Recording Engineer, John Clevenger; Financial Engineer, George Carpenter; Treasurer, William J. Beatty; Chaplain, Norris Warner; Senior M. M., Walter Guie; Junior M. M., David T. Davis; Inside Sentinel, G. W. Richardson; Outside Sentinel, John Carlson; Trustee, F. J. Armbruster; Delegate, Richard Wallace.

Germantown Council

The second open meeting and smoker of Germantown Council was given on Wednesday evening, January 14th, at their rooms at the corner of Germantown Avenue and Seymour Street, and to merely say that it was a success would be inadequate, for this magnificent young Council has enjoyed a succession of successes ever since it was formed last April. Their first open meeting, given last September, was pronounced by all to be a delightful affair, but the second one surpassed it in every detail. Local engineers throughout the entire Germantown section, and many prominent officers and members of the order were invited, with the result that the spacious rooms were crowded to their capacity. There was a delightful luncheon of cold meats, salads, relishes, rolls, celery, coffee, fruit and cakes, the latter being donated by lady friends, and were most delicious. Following the luncheon there was songs and good stories, with a little speech by L. L. Rice, and a lecture on the engineer's license law by Supreme Chief Williams, after which there was a general good time, winding up with a "stag" dance. Delightful music was furnished throughout the evening by piano and violin. A pleasant feature of the occasion was the presentation by the members of a handsome badge of the order to retiring Chief John P. Rickards, to whose boundless enthusiasm, tireless energy and magnificent executive ability much of the success of the Council is due.

The new officers of this Council were installed on Wednesday evening, January 7th, by Assistant Grand Chief John Kelley, and are as follows:

Chief Engineer, Leidy F. Souders; Assistant, George T. Lee; Recording, Joseph Rosbashil; Financial, Harry P. Fowden; Corresponding, Franklin MacIndoe; Treasurer, W. S. Wood; Chaplain, John Eccreson; Senior M. M., John Brayman; Junior M. M., Edward Reboul; Inside Sentinel, Isaac Springthorpe; Outside Sentinel, John Atkinson; Trustees, William Topley, William Doyle and John Jamison; Delegate to Grand Council, John P. Rickards.

Progress Council, No. 13 Resolutions

At a regular stated meting of Progress Council, No. 13, A. O. S. E., the following resolutions were adopted:

"Whereas, It has pleased Almighty God to remove from our midst our late brother member, John McGrail; and

"Whereas, It is but just that a fitting resolution of his many sterling qualities be had; therefore be it

"Resolved by this Council while we bow with humble submission to the will of the Most High, we do not the less mourn for our brother member who has been taken from us.

"Resolved, In the death of Brother John McGrail we lost a member who was always ready to offer the hand of aid to this Council and its members, whose utmost endeavors were exerted for the welfare and prosperity of this Council, a friend to all and an upright and honorable citizen.

"Resolved, As a mark of esteem and appreciation in which we held our departed brother, that our Charter be draped in mourning for a period of 30 days, and a copy of these resolutions be spread on the minutes of this Council, and a copy be sent to our official journal and the daily papers, and also a copy be presented to the bereaved family.

"F. S. Miller,
"A. B. Hess,
"John Kellenberger,
"F. M. Keterer,
"Committee."

Kensington Council

The new officers of Kensington Council, No. 3, of Philadelphia, installed, on Thursday evening, January 8th, are as follows:

Chief Engineer, Charles W. Leng; Assistant, Ed. Ricker; Recording Engineer, William B. Roland; Corresponding, Ernest Ritsert; Financial, Engineer, H. Meyers; Treasurer, Chas. Cook; Senior M. M., William Davis; Junior M. M., John Sullivan; Inside Sentinel, J. J. McCartney; Outside Sentinel, George Wheatcroft; Trustees, George Kennedy, William S. Stott and E. Ritsert; Chaplain, Frank Mellor; Delegate to Grand Council, C. W. Lenz.

The new officers have taken hold with energy and enthusiasm, and some rousing good meetings are anticipated.

Maryland Council

Maryland Council, No. 1, of Baltimore, informs us that they are still doing business at the same old stand, with plenty of new candidates coming in, and lots of gold in the treasury.

All the local engineers are trying to get in before the next oyster roast comes off. The following new officers have been installed:

Chief Engineer, George Goodwin; Assistant, L. Smithers; Treasurer, Peter Hagan; Financial, N. R. Pierson; Recording and Corresponding, William S. Smith; Chaplain, L. Cameron; Senior M. M., F. Denton; Junior M. M., F. Dolan; Inside Sentinel, W. Johnson; Outside, M. J. Doyle; Trustees, A. J. Diedrich, John McKewen; Delegate to Supreme Council, A. J. Diedrich; Alternate, W. S. Smith.

Lehigh Council

Grand Chief Trout visited Lehigh Council, No. 15, of Allentown, Pa., on Wednesday evening, January 14th, and installed the following officers:

Chief Engineer, John Durrin; Assistant, Henry C. Snyder; Senior M. M., John T. Lindstrom; Junior M. M., Jessie Williams; Recording Engineer, Al-

fred J. Strauss; Financial, Jacob Donnecker; Treasurer, John Burley; Corresponding Engineer, A. P. Dreisbach; Inside Sentinel, Oscar Roth; Outside Sentinel, Edmund Brader; Chaplain, Hiram Roth; Trustee, Martin H. Clewell; Delegate to Grand Council, Jacob Donnecker; Alternate, Robert Peifer.

Following the installation ceremonies the grand chief spoke encouragingly of the prospects of the A. O. S. E.

Progress Council

Grand Chief Engineer Trout installed the following officers of Progress Council, No. 13, of Reading, Pa., on Saturday evening, January 3d:

Chief Engineer, A. B. Hess; Assistant, John Kellenberger; Chaplain, Jacob Stoner; Corresponding and Recording Engineer, F. S. Miller; Financial Engineer, George F. Moyer; Treasurer, Henry Fritz; Senior M. M., Fred. M. Keterer; Junior M. M., Charles A. Corin; Inside Sentinel, Irwin R. Mosser; Outside Sentinel, Walter M. Walters; Trustees, Jas. Shirey and H. M. Trout.

Camden Council

On Thursday evening, January 8th, the following officers of Camden Council, No. 3, of New Jersey, were installed by Supreme Chief Engineer Clifford P. Williams, assisted by Bro. Mark Roland.

Chief Engineer, C. H. Harrigle; Assistant, S. M. Best; Recording and Corresponding Engineer, C. H. Pheiffer; Financial Engineer, H. R. Taliaferro; Treasurer, J. A. Graham; Sen. M. M., H. B. Cordiz; Junior, D. B. Orrins; Inside Sentinel, C. Mathews; Outside Sentinel, H. Hulings; Delegate to Supreme Council, C. H. Pheiffer; Alternate, H. R. Taliaferro.

Iron City Council

Iron City Council, No. 21, Pittsburg, Pa., have moved into new quarters in the Arnfeld building, Penn Avenue, near Eleventh Street. The place is new and equipped with every modern improvement and convenience for the accommodation of the members, including electric lights and steam heat. The new officers of the Council, installed by Deputy Grand Chief Engineer A. D. Hamilton, are as follows:

Chief Engineer, Jas. J. Stewart; Assistant, J. J. O'Sullivan; Recording, William Evans; Corresponding, Alexander Frasier, Carnegie, Pa.; Financial, Philip Sutton; Treasurer, W. J. O'Sullivan; Senior M. M., Martin Kane; Junior M. M., George J. Peters; Chaplain, Andrew Geist; Inside Sentinel, J. O. Couger; Outside Sentinel, Mathew Siemcer; Trustee, F. C. Rose.

Iron City Council is growing nicely, and already making preparations to show the delegates to the May Convention in that city a rousing good time.

Atlantic City Council

There are not a large number of engineers in Atlantic City, only fifty-two in Atlantic City Council, but those fifty-two appear to be possessed of the qualities that make men great—that is the ability to do something and do it well—for in everything that they undertake they seem to excel. Their latest accomplishment was a banquet given their members and friends at the Hotel Central, on Saturday evening, January 10th. There were a hundred guests, including visitors from Philadelphia, Wilmington, Baltimore and other cities. The banquet hall was handsomely decorated with flowers and bunting, making it good to look upon. The menu was very tempting and fully appreciated, even by Captain Doughty and "Billie" LeCompte, who have reputations as connoisseurs.

Small Rockaways
Celery — Radishes — Olives

Green Turtle Soup

Oyster Vol au Vent

Tenderloin of Beef Glace
Saratoga Chips

Chicken Croquettes French Peas

Roast Mallard Duck, Currant Jelly
Fried Hominy

Lobster Salad
Fromage Assortis

Nesselrode Pudding
Gateaux — Fruits
Demi Tasse

Grand Central Hotel

Haut Sauterne
Macon Vieux
Champagne
Segars

Chief William Fowden made an efficient toastmaster, and the only mishap of the evening was the breaking of the spring in a large music box just as Mayor Stoy began the first speech of the evening. It sounded like an earthquake for about ten seconds, but it didn't phase the Mayor. He blamed some of the boys for opening a blow-off cock. The Mayor is an old friend of the boys down there, and his speech was heartily applauded.

Postmaster Bacharach followed with a speech that was intermingled with fetching stories. Short speeches were also made by Supreme Chief Williams, Past Chief Frank Mellor and others. Many good stories were told, and altogether it would be difficult to imagine a more delightful evening.

An unusual feature of the occasion, which originated with Chief Fowden, was the manner of seating the guests. The name of each guest was written on an envelope enclosing the menu card, and these were distributed at random, one at each plate. When the banquet hall was thrown open for the guests to enter, they were told that each must find his own place. There was lots of fun in doing so. The menu card itself, which was 5x8 inches in size, was novel and very appropriate to the occasion. It consisted of a blue print of a boiler front, mounted upon stiff gray bristle board. Opening the upper doors revealed in golden letters the previously hidden secret of the good things to come. This was also the product of Chief Fowden's genius.

Previous to the banquet there was a short session of the Council for installation of officers, which are as follows:

Chief Engineer, William Fowden; Assistant, J. A. Best; Recording, W. S. Price; Financial, W. A. Hope; Treasurer, R. S. Peterson; Senior M. M., W. Gressman; Junior M. M., A. H. Franks; Trustee, A. M. Plummer; Chaplain, C. J. Noble; Inside Sentinel, C. B. Smith; Outside Sentinel, J. W. Frampton; Delegate to Supreme Council, R. S. Peterson.

Grand Council Notice

Whereas, The Grand Council, A. O. S. E., of Pensylvania, failed to provide a place of meeting for 1903; and

Whereas, I have received through Brother W. S. Wetzler, Corresponding Engineer of Philadelphia Council, No. 7, a kind and pressing invitation from the several Councils of Philadelphia to convene the Grand Council in that city.

Now, therefore, by virtue of the power in me vested, I hereby notify the Grand Council officers and delegates to assemble on Tuesday, March 17th, 9.30 a.m., sharp, for the transaction of business, at Philadelphia.

I trust that the delegates will all bring proper credentials, and that all corresponding engineers will send their semi-annual reports to the proper officers. Brothers, let us have a large attendance, and let this be a notable session, long to be remembered for its good work.

Fraternally,

HIRAM M. TROUT,
Grand Chief Engineer.

TRADE NOTES

A new catalogue, descriptive of the Case High Speed Automatic Engines, will be sent free to readers of The Practical Engineer upon application to the New Britain Machine Company, New Britain, Conn. The book has many illustrations showing the possibilities of their type of engine for various novel purposes, and it is probably one of the most complete books published upon the subject of small steam engines. It will be of value to anyone anticipating the application of small power engines for any purpose.

Messrs. C. J. Rainear & Co., 518 Arch St,. Philadelphia are sending out a very interesting circular explanatory of the Powell Patent Glass Engine Oilers, which will be interesting to any engineer, as it contains well illustrated matter upon the subject of successful devices for engine oilers. In addition to Powell's 20th Century valves, Messrs. Rainear & Co. make a specialty of wrought-iron pipe—not steel-cut to order from drawings. A postal will secure a prompt reply.

Scarcely an engineer but at one time or another has to make drawings or sketches of work, etc., and usually it is the hardest kind of a task. Write to J. & G. Rich, 120 and 122 N. 6th Street, Philadelphia, and ask for a description of the Rich Handy Drawing Outfit, it will interest you. By using this outfit anyone can make a neat drawing without having to worry about laying off measurements, etc. The appliance is so constructed as to meet such requirements mechanically and accurately. It is especially convenient for the occasional user as it contains provisions for holding any number of finished or partly finished work which you may have to refer back to.

A valuable little Booklet has recently been issued by Randolph Brandt, 38 Cortland St., New York City, which describes a nice line of engineers' and mill supplies, including Selden's Patent Packing, Brandt's Hot Water Square Piston Packing, Square Flax Packing, Wire Inserted Sheet Packing, Steam and Water Hose, Couplings and various other specialties. Copies will be sent gratis to any reader of this journal.

It pays to keep on hand a supply of good clamps for repairing leaky joints in steam pipes. It may seem like idle money, but they pay big interest when they save shutting down the plant. Jas. McCrea & Co., 67 West Washington St., Chicago, Ill., who manufacture the Climax Clamp, have records of scores of cases where their clamps have saved heavy losses. They will send you a catalogue describing their clamp if you are interested.

Some interesting information about steam economy is contained in the booklets which the William S. Haines Co., 136 S. 4th St., Philadelphia, want to send to each of the readers of The Practical Engineer who will take the trouble to write them. This company have several interesting specialties, chief of which is the Heintz Steam Saver—or trap with which engineers in every quarter of the globe are long familiar. This trap operates by the principle of contraction and expansion, being always open when water is at the discharge valve and immediately closing when the water has passed off.

There is still a chance to get one of the handsome catalogues of the United States Metallic Packing Co., 13th and Noble Sts., Philadelphia, if you send in for it at once. These catalogues are handsomely illustrated, and are a credit to an engineer's library. When writing mention "The Practical Engineer."

The Stellwell-Bierce and Smith-Vaile Co., manufacturers of steam pumps, air compressors, feed water heaters, etc., have removed their Philadelphia offices and salesrooms to 619 Arch St.

Engineers who are interested in feed water heaters for various conditions of service both vertical and horizontal, fire tube and steam tube, or in belt driven pumps for boiler feeding, etc., should write to Thos. McAdoo, 125 North Fourth St., Philadelphia, for one of his large, illustrated circulars.

A lot of good things for engineers are shown in the little catalogue of the Pilley Packing and Flue Brush Mfg. Co., 308 N. Main St., St. Louis, Mo. Various styles of packings are illustrated, and there are flue brushes in endless variety, but there are also other brushes for a score of different purposes; one is for cleaning the outside of condenser pipes, and another, known as Pilley's Quick Cleaner, is for general clean-

PATENTS

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Largest Manufacturers of Oil Filters in the World.
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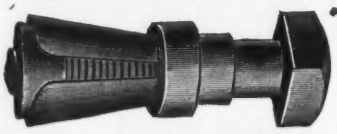
THE POSITIVE EXPANSION BOLT



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IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 440 Liberty Street, Allentown, Pa.

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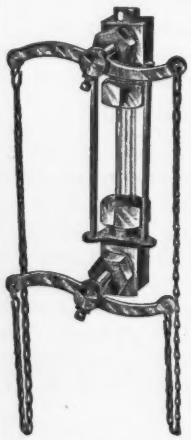

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1245 Betz Building
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ing around the engine room or work shop. There are also brushes for other special purposes too numerous to explain here in detail, but all practical for the purposes intended. A copy of the catalogue will be sent to any engineer mentioning this journal.

1903 Calendars. The crop of calendars for 1903 is coming in, and shows evidence of being much larger and of better quality than usual. Among the handsomest ones are the following: Pennsylvania Electrical and Railway Supply Co., Imperial Power Building, Pittsburg, Pa. This firm are general sales agents for Larkin Metallic Packing, Christensen Engineering Co., Christensen Engineering Co., Milwaukee, Wis.; H. B. Underwood & Co., general machinists, 1025 Hamilton St., Philadelphia. The Phillip Carey Co, Lockland, O., and C. W. Trainer Mfg. Co., 89 Pearl St., Boston, Mass., John Etherington, 392 King William St., London Bridge, E. C., has also sent us his 1903 calendar. A peculiarity of this calendar is that the dates are arranged vertically instead of horizontally as is the established American custom. Mr. Etherington is a consulting and inspecting engineer and manufacturer of engineering specialties.

A quick closing water gauge may save a painful burn, or it may save you the unpleasant experience of having all the water blown out of your boiler. One engineer ordered quick closing gauges after this had happened once. A better way would be to get them first. Paul B. Huyette, 1245 Betz Bldg., Philadelphia, sells them. They cost but a trifle. He will tell you more about them if you are interested.

Thwaites & Horner, electrical contractors, have removed their offices from 1215 Filbert St. to 1405 Filbert St., where they will be pleased to see their many friends and patrons. They are now better equipped than ever before to do all kinds of electrical construction and repair work.

After a thorough test and comparison, one of the large firms of the country placed an order on January 3 with the Sims Co, of Erie, Pa., for all of their "Sims" Oil Filters. Quite a good order, and seemingly very good evidence of the merit of the filter. The Sims Co. also manufacture a number of other specialties. To all interested they will send catalogue upon request. Mention this paper.

Mulconroy Co., 1213 Market St., Philadelphia, have engaged Mr. Wm. J. M. Weaver as manager of their large leather belting and mechanical rubber goods department. Mr. Weaver is well and favorably known to many of our local readers owing to his long connection with the engineers' supply business of this city. Mr. Weaver is thoroughly familiar with the line, and is a capable manager. He is an agreeable gentleman with hosts of friends and Mulconroy Co. are to be congratulated upon securing his services.

George F. Murphy, who was formerly connected with the De La Vergne Refrigerating Machine Co., R. Hoe & Co., these and several large concerns has just organized the Murphy Engineering & Machinery Company. The offices are located at 97-99 Nassau street. The company, in addition to general consulting and contracting engineering, will make a specialty of designing and installing elevating and conveying apparatus and special labor saving machinery.

Belt News—Revolution

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Liquid Belt Dressing, $1.00 per gallon.

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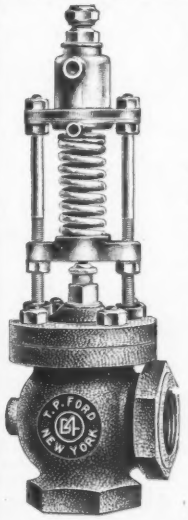

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COCHRANE OIL SEPARATORS

It is safe to say that the **COCHRANE OIL SEPARATORS** now in service have saved their owners (by permitting the use of exhaust steam for work formerly done with live steam), several millions of dollars. These Cochrane appliances give full protection to boilers from oil carried in exhaust steam.

We have no means of knowing how many dollars of engine repairs our **COCHRANE STEAM SEPARATORS** have saved. They're for insuring engines from water in steam. At the same time they make possible the gain that comes from using very dry steam.

WRITE FOR CATALOGUE 16 S

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American Order of Steam Engineers.

ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

DECLARATIONS OF PRINCIPLES

Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them ; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.—To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

An applicant for membership must be an engineer between twenty-one and fifty years of age, and must be a white male citizen of the United States, of good moral character and be a believer in the Supreme Being, and be free from all physical infirmities.

He must have had three years' service in an engineering department, or if a machinist, or graduate of a technical institute, then one year's service, in such department, and in localities where engineers are required by law to be licensed, they must have such license, and must satisfy the investigating and examining committees of the council to which he applies as to his character and ability.

LIFE MEMBERSHIP.

Engineers who have passed the age limit may be admitted to life membership. They must possess the same qualifications and pass the same examination as are required in the next proceeding clause: They shall be entitled to all rights and privileges of the Order except they cannot vote on financial questions or for the election of officers or be entitled to any sick or death benefits.

DIRECTORY.

The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting, to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

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Jennings Council, No. 2, meets every Saturday evening in American Bank. Chief Engineer, Daniel R. Jones. Corresponding Engineer, R. E. Funk.

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Energy Council, No. 2, meets every Wednesday of each month in Bauer Hall, Chesapeake and Elliott Sts. Chief Engineer, T. E. Eaton. Corresponding Engineer, Thos. O. Daneker, 834 East Ave.

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Deputy Supreme Chief for Eastern District, W. E. Packard, Whitmann.

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Boston Council, No. 4, meets 2nd and 4th Thursdays of each month, in Templar Hall, 724 Washington St. Chief Engineer, A. R. Abbott. Corresponding Engineer, Phillip Sanford.

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Old Colony Council, No. 14, meets 2nd and 4th Saturdays in the American Foresters' Hall. Chief Engineer, E. H. Naylor. Corresponding Engineer, Chas. W. Alden, Box 642, North Abington.

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Stevens Council, No. 1, meets 3rd Saturday, at Water, near Lafayette St. Chief Engineer, Lawrence Oliver. Corresponding Engineer, James H. White.

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Bridgeton Council, No. 5, meets every Friday. Chief Engineer, David Sellers. Corresponding Engineer, Francis O. Garrison, Bridgeton, N. J.

MILLVILLE.

Millville Council, No. 6, meets every Saturday, 7.30 P. M., in G. A. R. Hall, East Main St. Chief Engineer, Geo. Esabel. Corresponding Engineer, Lewis Doughty, 604 Mulberry St.

NEW YORK.

SYRACUSE.

John E. Sweet Council, No. 6, meets Monday, Room 23, Nottingham Block, East Washington St. Chief Engineer, John Cunningham. Corresponding Engineer, S. A. Steel, 311 Orange St.

PENNSYLVANIA.

Grand Chief Engineer, Hiram Trout, 1105 North Tenth St., Reading, Pa. Grand Corresponding Engineer, Frederick Markoe, 931 Orianna St., Philadelphia.

Deputy Grand Chief for Western Pennsylvania, A. D. Hamilton, 2025 Forbes St., Pittsburg, Pa.

PHILADELPHIA.

Germantown Council, No. 22, meets every Wednesday evening at Main and Seymour Sts., Germantown. Chief Engineer, L. F. Souders. Corresponding Engineer, Frank MacIndoe, 3529 Ainslie St., Falls of Schuylkill, Philadelphia.

Welcome Council, No. 2, meets every Friday, N. W. Cor. Twelfth St. and Columbia Ave. Chief Engineer, Paul Pieling. Corresponding Engineer, L. D. Woodington, 2428 N. Bancroft St.

Kensington Council, No. 3, meets every Thursday, at A. P. A. Hall, Frankford Ave. and Master St. Chief Engineer, C. W. Leng. Corresponding Engineer, Charles Fournier, 3113 Richmond St., Philadelphia.

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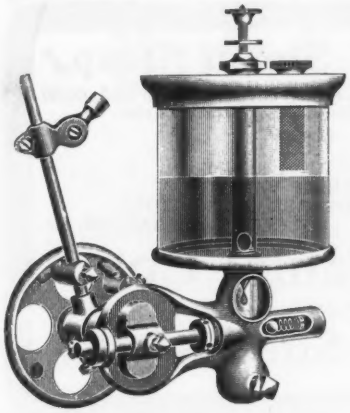

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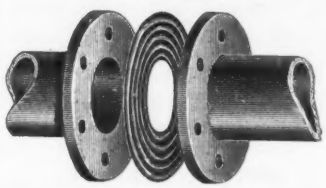

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Manayunk Council, No. 9, meets 2nd and 4th Friday evenings in Temperance Hall. Chief Engineer, John Hill. Corresponding Engineer, John Clevenger, 211 Lofty St.

Helping Hand Council, No. 12, meets every Thursday evening at Kensington Ave. and C St. Chief Engineer, Edward Laurence. Corresponding Engineer, Frank McHugh, 2503 Tulip St. All correspondence should be addressed direct to the Council.

Municipal P. F. D. Council, No. 20, of Philadelphia, meets the second Thursday of each month at Odd Fellows' Hall, Third and Brown Sts. Chief Engineer, Frederick Markoe. Corresponding Engineer, Walter Meyers, 1211 North Howard St.

PITTSBURG.

Iron City Council, No. 21, meets every Saturday at 1070 Fifth Ave. Chief Engineer, Phillip W. Sutton. Corresponding Engineer, F. C. Rose, care of St. Paul's Orphan Asylum, Idlewood, Pa.

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ALLENTOWN.

Lehigh Council, No. 15, meets every Wednesday evening at 639 Hamilton St. Chief Engineer, John Durrin. Corresponding Engineer, A. P. Driesbach, 728 Chew St.

POTTSTOWN.

Pottstown Council, No. 14, meets 1st and 3rd Saturday evenings at P. O. S. of A. Hall, Cor. High and Hanover Sts. Chief Engineer, Joseph Rhoads. Corresponding Engineer, H. L. Shirey, 362 Cherry St.

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Progress Council, No. 13, meets every Saturday evening at Diebert Hall, Ninth and Penn Sts., Room 4. Chief Engineer, A. B. Hess. Corresponding Engineer, Frank S. Miller, 3 West Franklin St.

CHESTER.

Delaware County Council, No. 6, meets every Wednesday evening in the Carpenter Hall, Sixth and Wall Sts. Chief Engineer, John Canavan. Corresponding Engineer, E. E. McCoy, 2222 West Third St.

YORK.

York Council, No. 16, meets every Wednesday Evening in the Jordan Block. Chief Engineer, A. L. Bair. Corresponding Engineer, Walter H. Long, 23 East Philadelphia St.

HARRISBURG.

Capitol City Council, No. 17, meets every Tuesday evening in Red Men's Hall, Market St., above Second. Chief Engineer, B. H. Shafer. Corresponding Engineer, S. Filson, 1126 Market St.

COLUMBIA.

Columbia Council, No. 18, meets every 1st and 3rd Saturdays, in Odd Fellows' Hall. Chief Engineer, Ruben Beard. Corresponding Engineer, W. J. Courtney, 804 Walnut St.

SUNBURY.

Sunbury Council, No. 19, meets every 2nd and 4th Saturday in Zartman's Hall. Chief Engineer, S. E. Lees. Corresponding Engineer, Ed. Schrieber.

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Deputy Supreme Chief Engineer, Joseph P. Harris, No. 1611 Clybourn St., Milwaukee.

MILWAUKEE.

Washington Council, No. 1, meets every Saturday at 207 Grand Ave. Chief Engineer, J. B. Chambers. Corresponding Engineer, James A. Rigby, 136 Reed St.

Clifford P. Williams Council, No. 2, meets every Thursday evening at 298 Fourth St. Chief Engineer, David T. Richardson. Corresponding Engineer, Jas. T. Harris, 1611 Clybourn St.

TENNESSEE.

Deputy Supreme Chief Engineer, John B. Mullen, 826 Central Ave., Nashville.

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Enterprise Council, No. 1, meets every Friday evening in the Twin Building on Cedar St. Chief Engineer, J. J. Johnson. Corresponding Engineer, Jno. B. Mullen, 209 Jackson Building.

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Deputy Supreme Chief Engineer, Nat. Freese, Grant's Pass, Oregon.

GRANT'S PASS.

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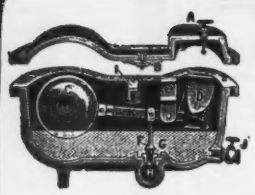

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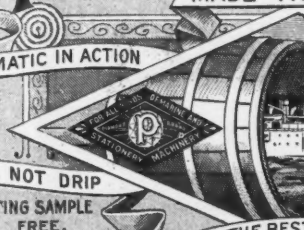

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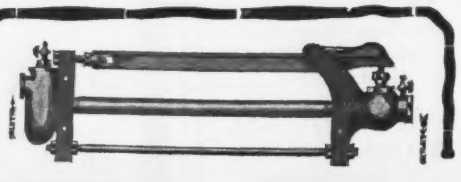

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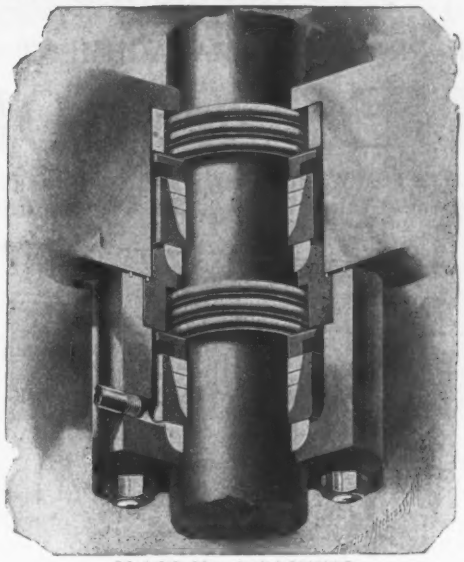

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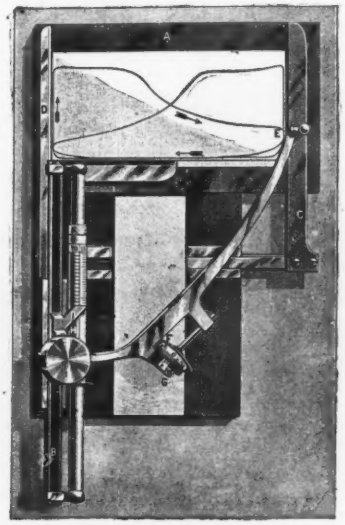

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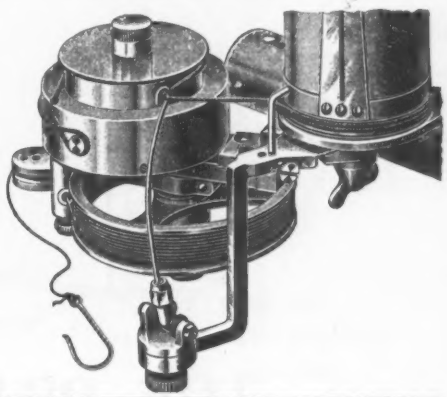

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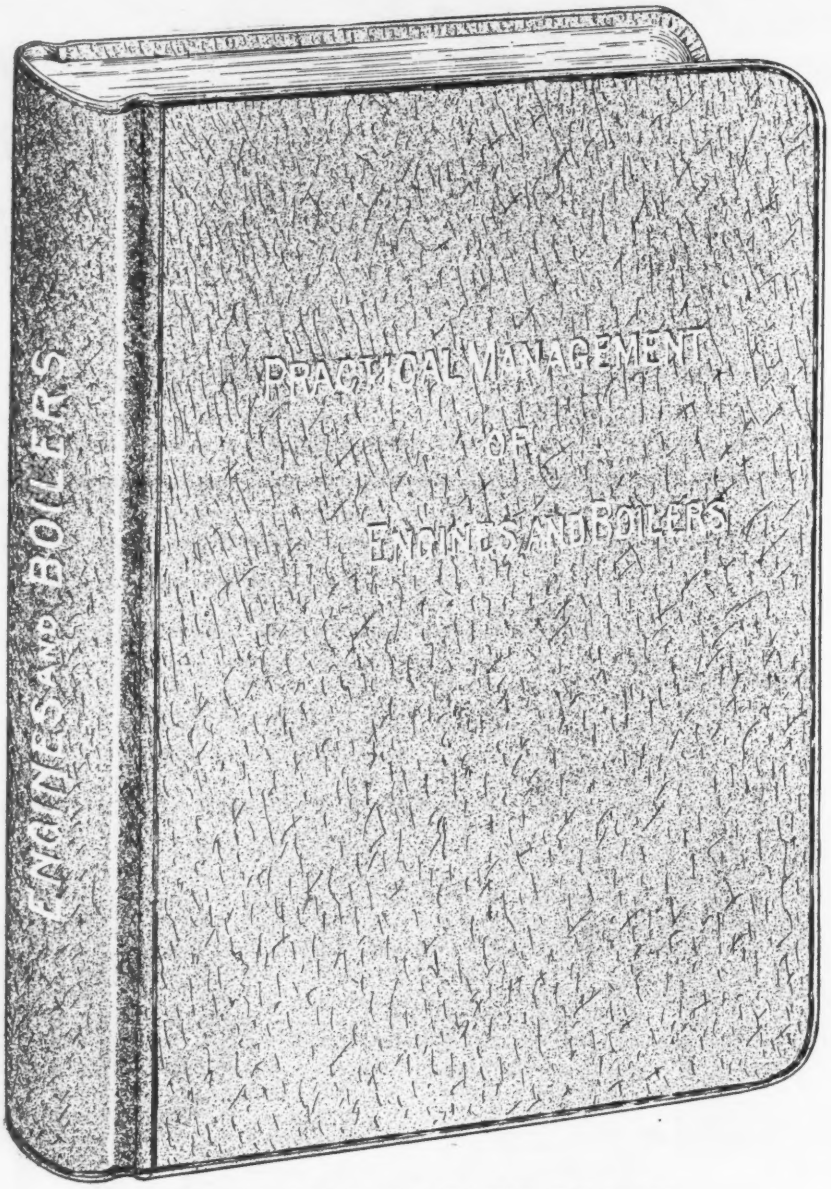

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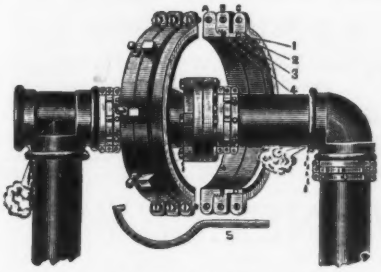

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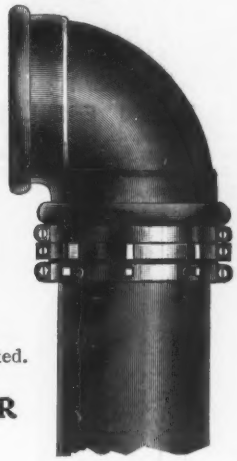

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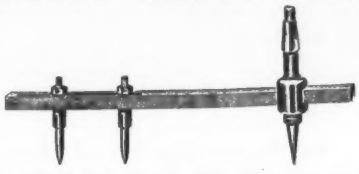

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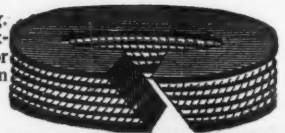
Self-lubricating, Steam and Water Tight, Less Friction than any other known packing. **None Genuine Without This Trade Mark Stamped on Wrapper.** All similar packings are imitations. In ordering give exact diameter of Stuffing Box and Piston Rod or Valve Stem. Our Packing is a sure cure for leaky stuffing boxes, whether the motion is rotary or reciprocating.



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SELDEN'S PATENT PACKINGS

made either with **Rubber or Canvas Core** and both **Round** and **Square** in shape. Will give satisfaction on Engine, Pump, Compressor and Valve Rods. Easiest of all packings on your rods.

Brandt's Triple Expansion Gaskets

For Boiler Work and

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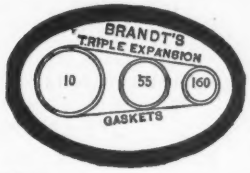

are the very best goods you can use in **High-Pressure** work. Engineers are requested to give the above a trial if they are not now using them.

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Lamprey Protective Arch Plates

Protect your boiler fronts from burning out, preserve the brick work, save fuel, and increase the efficiency of your boiler, by giving additional heating surface. Save their cost in repairs alone.

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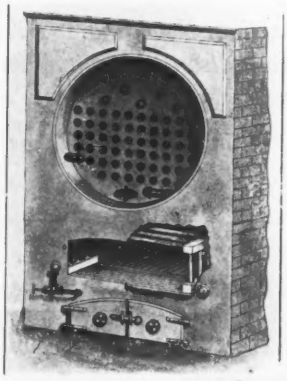

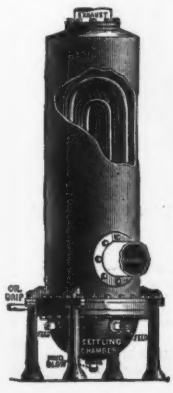

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PATTERSON EXHAUST HEADS

PRICES AWAY DOWN
Sold on trial: to be returned at our expense if unsatisfactory. [We never had one come back yet]

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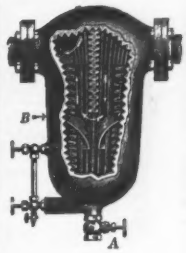

IF you really want to keep water out of engine cylinder or oil out of boiler you certainly want a HINE ELIMINATOR — more than 5000 users will say a good word for it.

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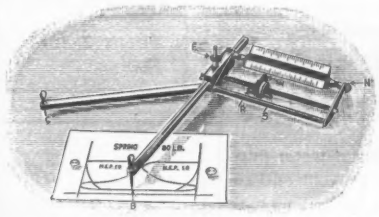

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Requires LESS steam than any other cleaner.
Will positively clean BETTER than scraper or brush.
Will clean ANY length tube.
In operation is EQUALLY balanced, insuring NO back pressure against operator.
Is the LIGHTEST and EASIEST cleaner to handle.
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Its force is tremendous.

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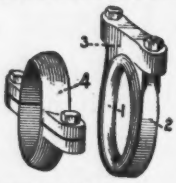

1 Packing Ring.
2 The Flexible Yoke.
3 Cross Head.
4 Split Collar, which keeps the packing in place.

IF you have a leaky joint dripping water over valuable property, use one of **SMITH'S CLAMPS** and it will make a permanent repair.
It has no equal for simplicity, durability and low cost.
If your leak is in an inaccessible position, the use of our clamp will prevent having to tear out the piping. The illustration will tell the rest.
This Clamp is particularly adapted to close pipe connections, as it occupies less space than any other Pipe Clamp manufactured, and is cheaper, too.
In ordering, state size of pipe and for what it is used. Write for price list.
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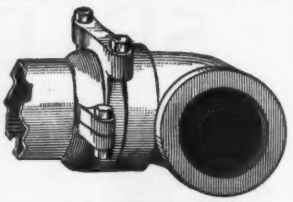

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Excelsior Lubricant

Our Lubricant is a lubricating compound, made from several of the best known lubricating oils, contains *no acids*, does *not gum* or *run*. It *cools hot journals* and *keeps them cool*.
It is applied by being packed in cups fitting air-tight on the journal, and feeds by suction, therefore there is no wasts when the journal is stopped. One cupful lasts from **2 to 10 months.**
We are running bearings and keeping them cool where before they could run only by the *constant application of water*.

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that do this without injury to the boiler, its fittings or connections;

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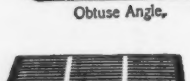
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WAS THE FIRST

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EVER USED FOR REMOVING SCALE FROM BOILER TUBES

Mr. Weinland himself, a *practical engineer, being the "PIONEER"* and *first INVENTOR* in this line.

Our improved machines to-day are the natural outgrowth from our ORIGINAL MACHINE, which contained the *basic elements* of all present day Turbine Cleaners.

We assure our friends that we do not infringe anybody's patents, and *will fully protect our customers from annoyance by alleged infringement suits of any kind*, published threats of which only emphasize the MERIT OF WEINLAND CLEANERS and their dreaded competition.

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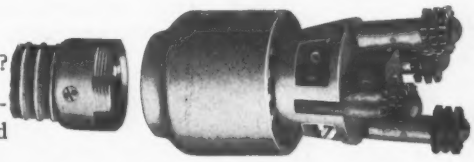

Compare this cleaner with any other. Does it resemble any?

One prominent, experienced and practical Inventor and Manufacturer remarked: "No! It is so unlike as to call attention to its marked superiority."

We will send it to be tried with any other Cleaner made, and with each machine we furnish full protection as above.

We are responsible and can make this guarantee good—consult Dunn, and Bradstreet, or any bank in this city.

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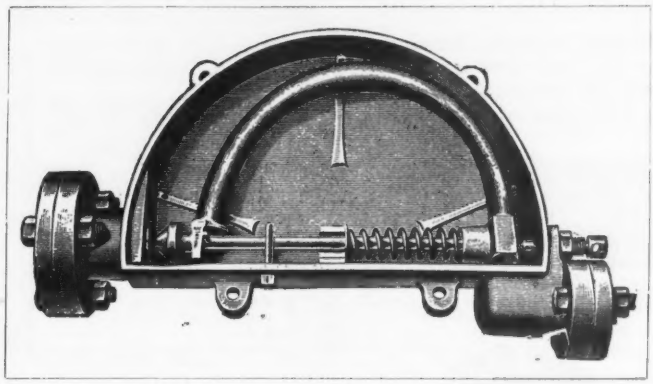

The coal you don't burn

is clean, clear profit. You double that profit the day you put the Heintz Steam Saver in your plant.

It saves two tons where other traps save one, and still it saves, when other traps are done.

THE HEINTZ STEAM SAVER

only wants a chance to get its nose inside your door, like the camel in the story ; it will take care of the rest. For example, Mr. G. M. Brill, the well-known car builder, said at first, "There isn't a place in our establishment where we could use your trap." All the same he is now using over **one hundred** of them in that same establishment. As soon as people find out what one of the Heintz Savers saves, they soon find places for more. Look out for imitations.

The Heintz Steam Saver is made in nine sizes, capacity one quart to 240 gallons a minute. Any size sent on 30 days trial ; no charge unless satisfactory. Guaranteed for one year.

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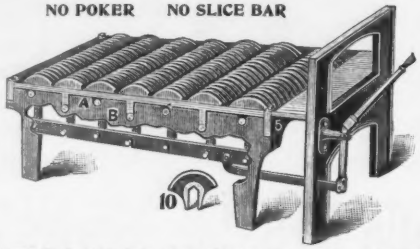
PAT. "AJAX" ROCKING GRATES.

The only shaking grate that will not get clogged up with clinkers.

The "Differential" motion does it. The crossbars A and B are journaled one on a higher plane than the other, and in rocking pass through the arc of a different circle bringing the two bars close together, which supports the bed

NO POKER NO SLICE BAR



of fuel, only allowing the ashes and clinkers to pass through.

Surface of grates **ALWAYS REMAIN LEVEL.** No fingers or points to disturb fire. Small clips No. 10 are all that can burn out and cost only a few cents each. Air space 65 per cent.

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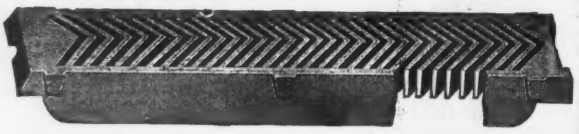
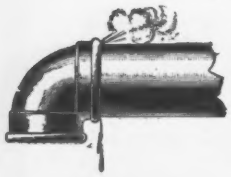
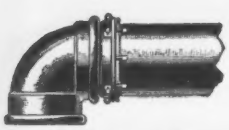


Frick's Pipe Clamps for Stopping Leaky Pipe Joints





The **Best, Simplest** and cheapest **Pipe** clamp made. The cuts explain themselves. Only two rings and the packing needed to make any leaky joint tight. It is so simple that anyone can apply them.

The cost as compared with others is so little that owners of steam plants cannot afford to be without a full set of all sizes in case of need.

We make all sizes from 2 inches to 14 inches in diameter

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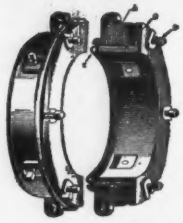

A—Outside or main ring which is bolted around the pipe as close to leaky joint as possible, and secured to pipe by the setscrews.
B—Gland which will slide backward or forward under the main ring and is forced up against the packing ring C by bolts and Nuts D
C—Empire or rubber ring which is forced into leaky joint by Gland B.

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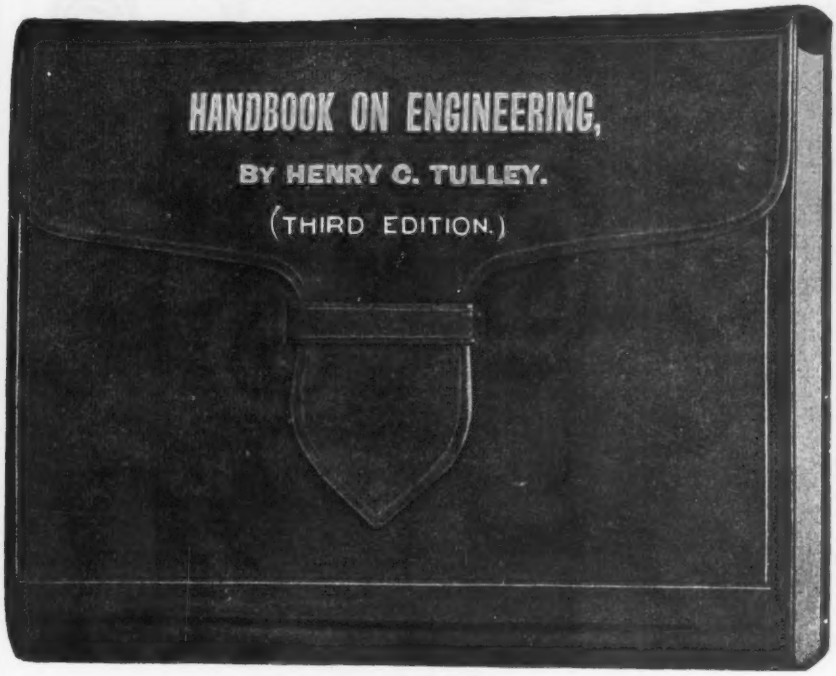

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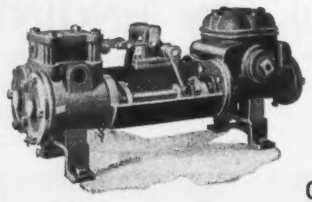

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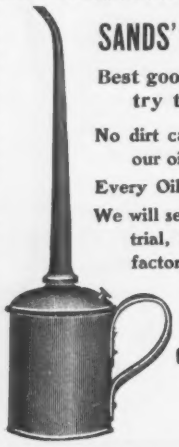

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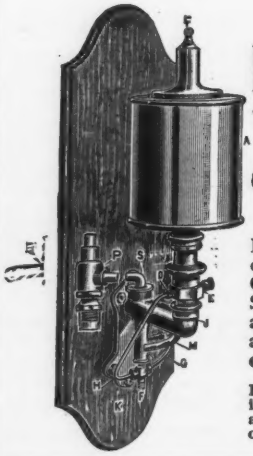

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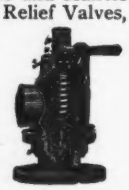

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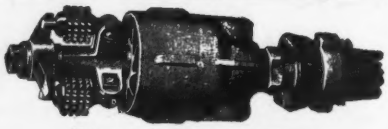
IS THE ONLY PRACTICAL MACHINE FOR REMOVING SCALE FROM

WATER TUBE BOILERS



NIAGARA TURBINE, PATENTED

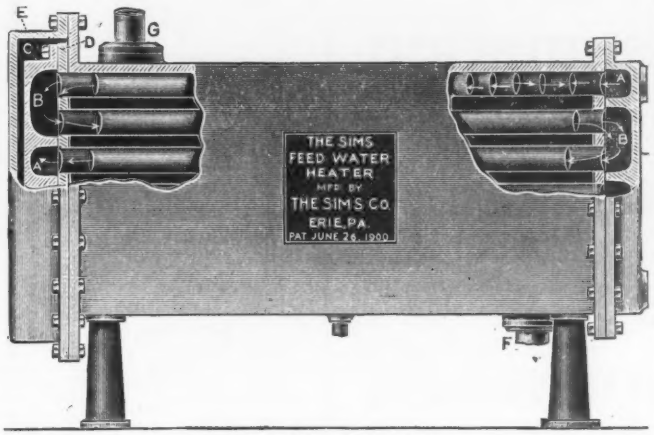
THE **PATENTS** which we control cover all features essential to the design of a practical **TURBINE TUBE CLEANER**

We have suit for infringement pending against a user of the Lagonda or Weinland machine, and will prosecute all other INFRINGERS.

LIBERTY MANUFACTURING CO. 5988 Centre Ave. **Pittsburgh, Pa.**

Proprietor. Say, Tom! why do we get such poor results with our Feed-Water Heater?

Engineer. Oh, that is easy, the water does not circulate through more than half the tubes, and they are probably badly scaled, and it is impossible to clean them. What we need is a "Sims" Feed-Water Heater. I understand the water has to circulate through every foot of tube, and that they can be scraped as easily as a boiler tube. You had better write them for a catalogue and see what they guarantee, and how their prices are.



HORIZONTAL STYLE

For Circulars and Prices, Address

Thomas McAdoo
125 North Fourth Street
Philadelphia, Pa.

The **OTIS** Tubular Feed Water Heater, Oil Separator and Purifier

with Seamless Brass Tubes

Guaranteed

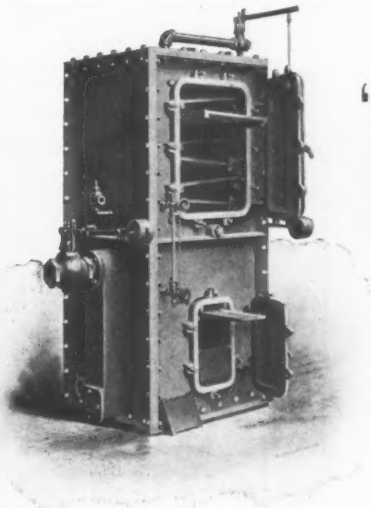
To heat the feed water to the boiling point (210 or 212 degrees) with the exhaust steam without causing any back pressure, **also to extract the oil from the exhaust,** so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the additional expense of an eliminator.

A Liberal Offer

If this heater fails to give satisfaction in every respect, we pay freight, cartage, etc., both ways.

The **Stewart Heater Co.**

11 Norfolk Ave., Buffalo, N. Y., U. S. A.



What "Saving" Means

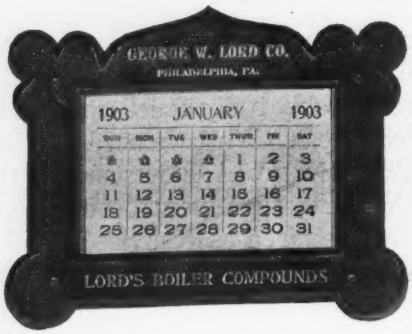
It's easy to save a dollar in heat by wasting ing two in power—and some feed-water heaters save in that way. That isn't what we mean by saving.

Webster Feed-Water Heaters and Purifiers

not only save all drips, and use the least steam to heat them again, but they stop back-pressure on the engine. That is why their saving shows in the size of the coal-pits.

980,000 h. p. in use. If you want more arguments besides that, write us.

Warren Webster & Co.
CAMDEN, N. J.



Scale in the Boiler

INCREASES

Fuel Consumption

Now that coal is scarce, fuel cost is a big item

LORD'S Boiler . . . . Compounds

Will remove every trace of scale

They are dry non-corrosive powders prepared especially to suit the particular requirements of each case.
Contain nothing harmful to the metal.
Made to remove the incrustation and it never fails. Cannot fail to do the work for which intended.

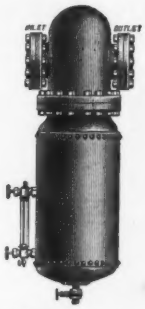
If you send us a **specimen of the scale** in your boiler, **we will analyze it**—send you results, and give you a written guarantee to **remove the scale** without harm to the boiler—**or no pay.**

GEO. W. LORD CO.

2238-50 North Ninth Street
PHILADELPHIA

We Send Our Calendar To Engineers Who Forward Us Samples Of Boiler Scale For Analysis

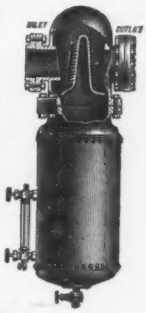
Have You Received One Of Our Handsome Leather Desk Calendars?



"Figure L. Horizontal Cast Head Separator"

Our Side of the Story

And *the* Evidence *of* a Large Number *of* Leading Steam Plants ——That Use——



"Sectional View Figure L. Separator"

Austin Separators

is ready to be sent you in the form of a new Catalog which we have just issued. It shows these Separators in the wide variety of styles and sizes which adapt them for every requirement of steam users—extreme high pressure, extra steam storage, large water capacity, etc.—special patterns provide for every need. Their efficiency for

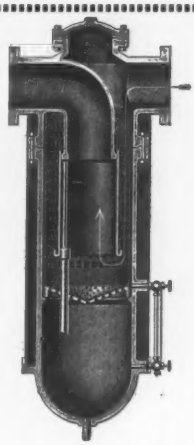
Removing all Moisture from Live Steam, And Extracting all Oil, Grease and other Impurities from ——Exhaust——

is best guaranteed by our offer to send a Separator on THIRTY DAYS' TRIAL, to any responsible concern, with the privilege of returning it at our expense if it doesn't satisfy. Cuts show exterior and sectional views of Fig. "L" horizontal cast head and large Steel Shell Receiver Separator.

Write for Catalog To-day

AUSTIN SEPARATOR COMPANY

65 Woodbridge Street DETROIT, MICH.



Thousands

Of little gutters are provided in **Sweet's Separator** for conducting the oil and water from the steam current and not a drop can get back. This is only one of many reasons why 50 per cent. of them are sold on duplicate orders.

2,700 in Use, All Styles

Let us Send Our Story

WE ALSO MAKE

EXHAUST HEADS & STEAM TRAPS

DIRECT SEPARATOR CO.

200 Marcellus Street

SYRACUSE NEW YORK

R. S. SPENCER, Philadelphia Representative, 1218 FILBERT ST.

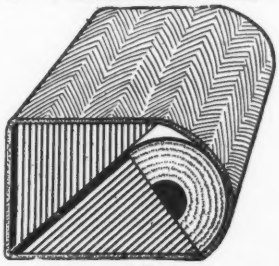
40 PER CENT. SAVED

PILLEY'S EXPANSION WEDGE PACKING

THE ONLY PACKING HAVING A PERFECT EXPANSION AND PRACTICAL WEDGE MADE IN 12-FOOT LENGTHS OR

CUT AND MOULDED INTO RINGS

TO FIT YOUR RODS



Latest and Best

This is the most economical wedge packing on the market, and as it is not loaded with **unnecessary** Oil and Tallow it weighs about one-half per foot of other wedge packing, thus making a saving of fully 40 per cent. in cost of packing.

See that this trade mark is on all Pilley's Packings

ALSO SOLE MANUFACTURERS OF

PILLEY'S IMPROVED RING PACKING

Sent on Thirty Day's Trial to Responsible Parties

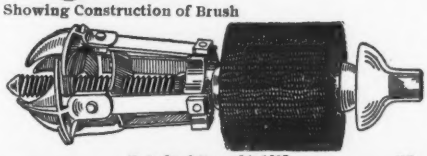
Showing Construction of Brush

A RECORD FOR RELIABILITY IS BEHIND THE IMPROVED

PILLEY EXPANSION FLUE BRUSH

It is Guaranteed Not to Break, Being Made of Malleable Iron and Tempered Steel

It Cleans the Entire Flue Every Time it is Pushed Through Brush ready for use



Patedted June 14, 1892

Keeps your tubes clean and saves money. **Pilley's Combination Flue Brush and Scraper** is the simplest and best cleaner on the market. A simple turn of the hand adjusts it to the tube and the brush removes what the scraper loosens. Guaranteed not to break nor the wires come out or lay over. Sizes from 2 inches up. Measure outside diameter of tube.

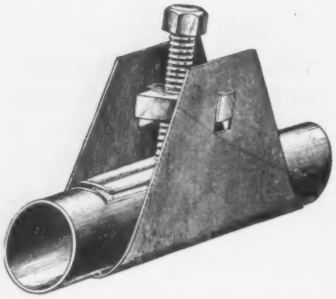
PILLEY PACKING AND FLUE BRUSH MFG. COMPANY, 308 N. Main St., St. Louis, Mo.

——FOR SALE BY——

Tatum and Bowen, San Francisco, Cal., Portland, Ore., and Seattle, Wash. Crane Co., New York City. S. H. Supply Co., Denver, Colo. Eagle Oil and Supply Co, Boston, Mass. Chas. Bond. 522 Arch St., Philadelphia, Pa. Scranton Mercantile Co., Scranton, Pa. Strong Machinery and Supply, New York City. New Orleans Railway and Supply Co., New Orleans, La.

Send for Our 70-Page Memorandum Book—FREE TO ENGINEERS

Purdy's Pipe Clamps



Effectually stops leaks in all kinds of steam and water pipes.

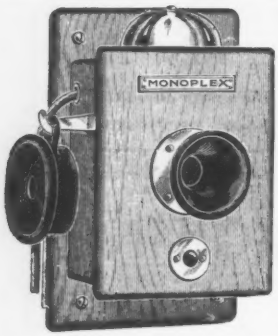
Easily adjusted, saves engineers worry and trouble.

Ask your jobber for them, or send to

BARRETT & PLOWMAN
11 North Front St., Philadelphia

We also have the **Climax Steam Joint Clamp** for leaky steam joints.

Send for Catalogue



$2.50 EACH
$5.00 PER PAIR
MONOPLEX TELEPHONE
Talks Perfectly
Rings Perfectly
Perfect in every way
Atwater Kent
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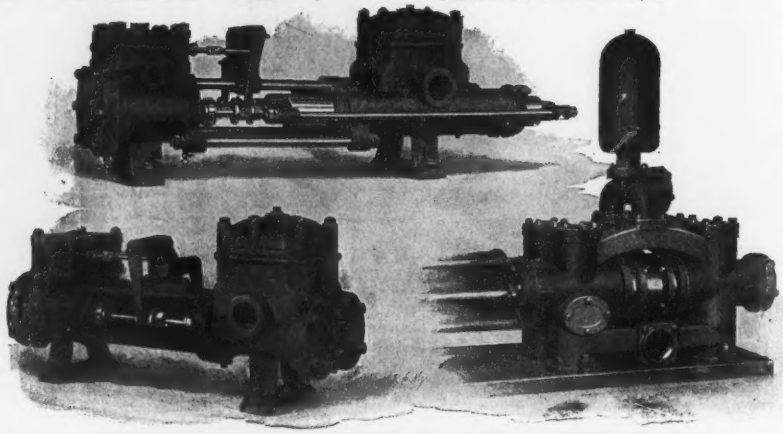
GARLOCK
HYDRAULIC LEATHER CUP
has been given the hardest tests, and pronounced by hydraulic engineers to be the strongest and smoothest on the market.

Send us a trial order, and if you don't find them right return them at our expense. They are made of pure oak tanned leather in natural color.

GARLOCK PACKING CO.
604 ARCH STREET, PHILADELPHIA

PUMPS Steam, Belt or Electric Power
FOR ALL PURPOSES



BARR PUMPING ENGINE CO.
NOT IN THE TRUST
WORKS, GERMANTOWN JUNCTION
CITY OFFICE, 55 N. 7TH ST., PHILADELPHIA

THE ROSE PATENT GRATE
A THOROUGHLY UP-TO-DATE SHAKING GRATE FOR PARTICULAR ENGINEERS. WRITE FOR CATALOGUE.

THE KUTZTOWN FOUNDRY AND MACHINE COMPANY
MAKERS OF HIGH GRADE
Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

Works: KUTZTOWN, Penna.
Philadelphia Office: Fidelity Building, Broad, above Arch

STEAM FITTING
if not properly done, in any plant, will cause the engineer a great deal of trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

WILLIAM MILLIGAN, Shop, 726 Sansom St., Philadelphia, Pa.
'Phones: {Bell-Market 37-99a / Keystone-Main 1-71
JOBBING A SPECIALTY

General Engineering and Repairing. Reboring Cylinders in Present Position from 3-110 in. Dia., and Turning off Dynamo Commutators without removal.

CAST IRON GRATE BARS
SECOND-HAND TANKS
PHONE 5-27-73

If in Doubt

What Injector to buy,
Run No Risk, but get

THE U. S. AUTOMATIC INJECTOR

Three Safeguards Against Disappointment

1. Each Injector is carefully tested on varying lifts and pressures before leaving the factory, and a card attached showing its range and grading capacity.

2. Any dealer will guarantee the U. S. Injector, because:

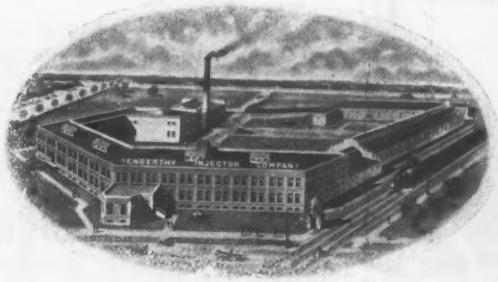
3. We stand back of the dealer, and will replace any injector that doesn't work right, or refund the purchase price if necessary.

Our guarantee of absolute reliability brings us hundreds of new customers each season.

Full particulars and many items of interest are contained in our "Engineers" Pocket Reference Book. Shall we send a copy?

AMERICAN INJECTOR CO.
DETROIT, MICH.

THE NEW HOME OF THE



WORLD RENOWNED

TRADE **PENBERTHY** MARK.

AUTOMATIC INJECTOR

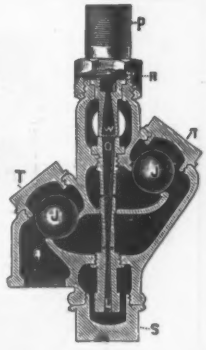
Our new factory, just completed, is one of the finest brass manufacturing plants in the United States, being equipped throughout with the latest improvements in brass working machinery, including electric distribution of power. We are now prepared to take prompt care of all orders, and shall aim to make the "Penberthy" in the future, as it has been in the past, the

STANDARD AUTOMATIC INJECTOR OF THE WORLD

Penberthy Injector Co. 356-352 HOLDEN AVENUE DETROIT, MICH.

Largest Injector Manufacturers in the World.

BALL VALVE *The Lee* AUTO-MATIC



INJECTOR

PERFECTION HAS NOT A SUPERIOR SIMPLICITY

HAS NO EQUAL

The Lee PATENT

STRAIGHT-WAY
HORIZONTAL AND ANGLE
Ball Check Valves

SEND FOR CATALOGUES

MANUFACTURED BY

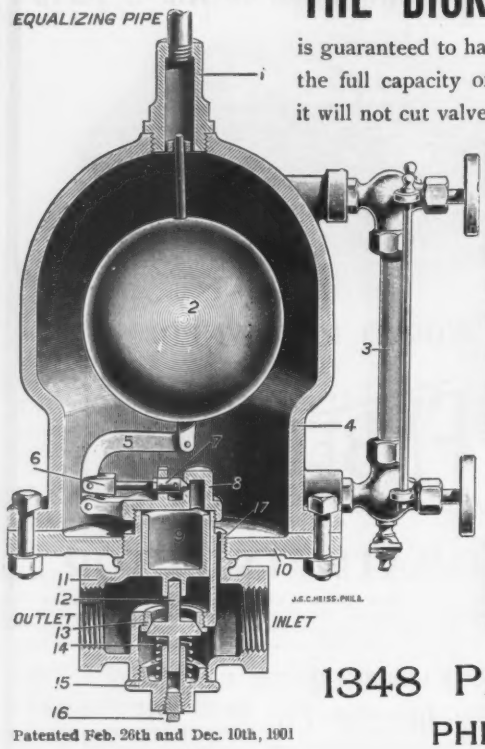
The Lee Injector Mfg. Co.
99-101 ABBOTT STREET
DETROIT, - MICH.

SUPERIOR TO ALL

This Trap is Specially Adapted for Separator Work

THE BICKEL FLOAT STEAM TRAP

is guaranteed to handle more water than any trap made. It has the full capacity of pipe connections. It will respond instantly; it will not cut valves, and is **specially adapted for Separators.**



Patented Feb. 26th and Dec. 10th, 1901

THE BICKEL FLOAT STEAM TRAP

For Pressures from 5 to 300 lbs.

The Bickel Thermostatic Steam Trap

is not adapted for Separator use or bleeding steam mains, but is unexcelled for every other service to which a trap can be put. It will respond quicker and last longer than any other expansion trap. Can be set to discharge water at any temperature. Will not cut valves.

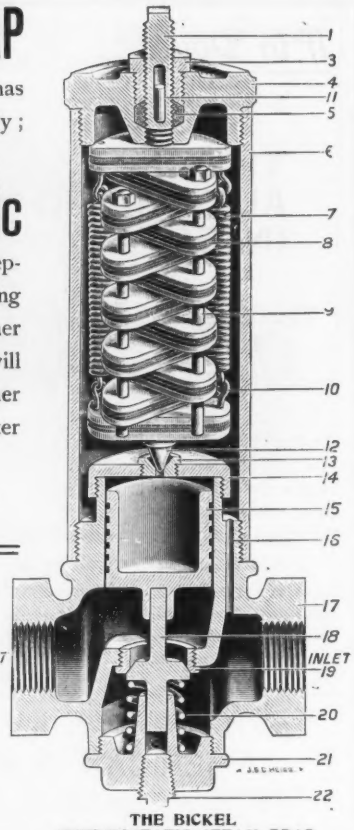
Either of these Traps sent to responsible parties on trial.

Fred. L. Bickel

1348 PALMER STREET,

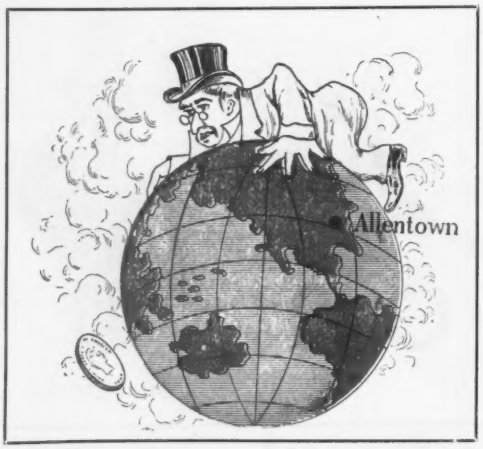
PHILADELPHIA, PA.

REPRESENTATIVES WANTED IN ALL CITIES



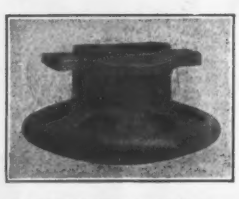
THE BICKEL THERMOSTATIC STEAM TRAP

For Pressure from 5 to 300 lbs.



THAT ONE IS GONE

But there are lots of other good, hard dollars you can get, if you go after them right, and in the pursuit and capture of these dollars nothing will aid so much as, A Steam and Oil Separator equipped with automatic trap inside or a Separator inside of your boiler which will keep the water in your boiler, or a Steam Trap which has no pins, screws, or valves, that can stop up, or to have your steam cylinder rebored and fitted with steam-tight packing rings. This kind costs no more than poor kind, but pays a lot better. May I see you about it?

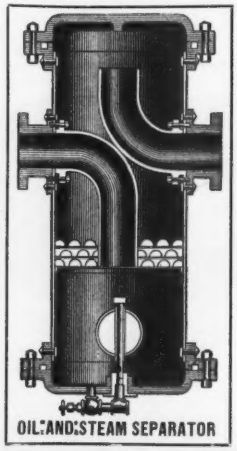


FOR INTERIOR OF BOILER

JOHN T. LINDSTROM

440 Liberty Street

ALLENTOWN, PA.



OIL AND STEAM SEPARATOR

SPECIAL NOTICE

KEYSTONE GREASE

is not only better and cheaper than any other grease made for lubricating Steam Engines and all other kinds of Machinery, but it

is made different

from lubricating greases sold by the oil and supply trade, and made by some refining company. Keystone Grease is manufactured and sold only by the

Keystone Lubricating Company

and has no connection, either directly or indirectly, with any Oil Refining Company. Keystone Grease is to the 20th Century, King above all lubricating greases; it is owing to its great wearing properties, and the wonderful results attained from its use, that our enviable competitors seek to prey upon the unsuspecting purchaser with some false assertion to insure the sale of their cheap and common product.

We are compelled to make this statement because it has come to our notice that Manufacturers and Engineers in many sections of the United States have been led to believe that Keystone Grease was the same as the cheap greases made by Oil Refining Companies. Keystone Grease has no such relation, the great wearing properties of Keystone Grease and its pureness has created a demand and recognition for it all over the world.

To be convinced of the truthfullness of our assertions, and the great claims made for the best grease known to the Scientific and Mechanical world to-day,

SEND FOR A SAMPLE AND CUP, FREE OF ALL CHARGE AND EXPENSE, TO THE : : : : : :

Keystone Lubricating Company

20th Street and Allegheny Avenue, Philadelphia, Pa., U. S. A.

HOUGHTON'S MONTHLY LETTER TO ENGINEERS

Dear Mr. Engineer:

Do you know anything about steam traps? Perhaps, yon think you know it all. If you are like some engineers we know, you believe best place for all steam traps is junk pile. Such engineers have had experience with bad kinds of traps. Those with levers, springs, balances, etc. MARCK STEAM TRAP should never have been called a trap. It is more of an automatic valve. In fact, it is nothing else. It is automatic, inasmuch as it will not permit water to remain in steam pipes, nor steam to escape. It is always open when not in use. MARCK STEAM TRAP can be speedily and easily adjusted. First cost is small. Engineer wrote us other day, his fireman died of consumption, owing to lack of proper exercise, after he equipped his plant with MARCK TRAPS.

Perhaps you do not think MARCK TRAPS are best. Perhaps, you have been influenced by howl of dying dog. That dog is gone too far to hurt. Acknowledge that. Hitch up with live people.

Here is how you can ascertain all about MARCK TRAPS to your hearts content. Send to us for MARCK STEAM PIPE TRAP CATALOG. Then when you ascertain from catalog size and quantity of traps wanted, order them and use them for 30 days. At end of that period send whole shooting match back, if you feel so inclined and we will cancel charge in full.

We are selling oil filters. Now we WILL be called "IMITATORS." We made first practical oil filters for lubricating oils ever used. Made them back in sixties. Were first successful manufacturers of filtered lubricating oils and everyone knows it, who knows anything about business.

We could have made a practical, simple, cheap engine room filter at any time, but our business up to 1897 was exclusively oils. Since 1897 were too busy till present time to get out our own filter, so sold other makes.

Tom foolery nonsense about these other filters made us determine to give oil consumers a simple, low-priced apparatus, that would do just what was wanted and nothing more.

We call our filter "HOUGHTON OIL FILTER," because we can think of no name that will carry more confidence to engineers than "HOUGHTON."

As to price, we are fairly giving away filters, when you consider cost. Ever notice engineers who hold arms partly back of them, crooked-like? Got that way trying to clean some of TOMMY ROT filters. HOUGHTON'S is a bird to clean.

Send for HOUGHTON FILTER CATALOG.

E. F. HOUGHTON & CO.

184 Lake Street, Chicago 254 W. Somerset St., Philadelphia

Machinery Hall, Philadelphia Bourse

JOHN J. SPROUL, Vice-President and Manager W. J. GREENHOUGH, Secretary and Treasurer

HAVE YOUR

ELEVATORS

REPAIRED

— BY —

Keystone Elevator Inspection and Repair Co.

Removed to **923 Locust Street, Philadelphia**

Bell, 3-22-58 BOTH 'PHONES Keystone, Race 10-20

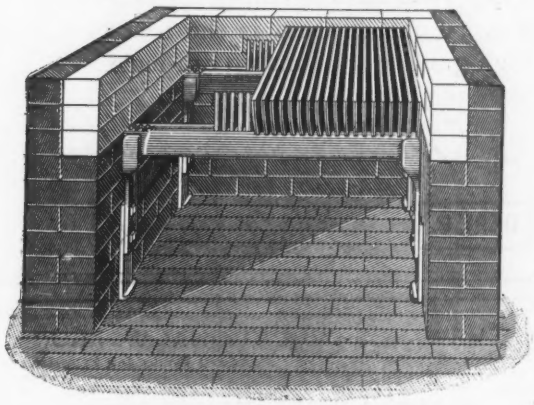
We Carry Repair Parts in Stock, and Will Work Holidays and Nights When Necessary

ESTIMATES ON NEW WORK

WE MAKE ALL TYPES OF

GRATE BARS

But This is the Best and Cheapest



The Longest-lived Grate Bar That Ever Lived.

IMPROVED AMERICAN GRATE BARS

PATENTED

THE ONLY GRATE WITH ADJUSTABLE FRAME.

THE ONLY GRATE WITH LOOSE TEETH BETWEEN THE BARS.

We wish to call your attention to a few important points in our new Furnace Grates.

The adjustable supporting frame, not coming in contact with the brick-work, saves the walls from getting loose, and can be adjusted to any height desired. The perforated supporting cross bar has less obstruction to a free circulation of air than any other Cross Bar made. The movable teeth between the Grate bars can easily be changed at any time, so as to give an air space between the bars that is desired to accommodate any size of fuel; the Movable Teeth also give the bars more freedom to expand and contract, thereby the bars are less liable to warp.

The American Grate Bars have given satisfaction where others have failed. Are made and for sale only by us; other parties have no right to make or sell them.

Send for circular and references. **E. J. MOORE MACHINE AND FOUNDRY CO., Sole Mfrs.**

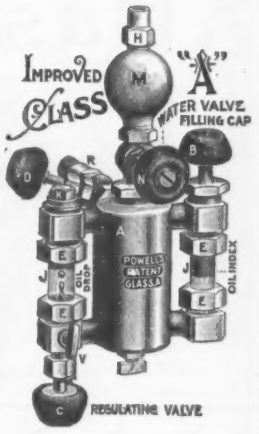
2225-2227 WOOD STREET PHILADELPHIA, U. S. A.

POWELL'S

SIGHT FEED

CYLINDER LUBRICATORS

and Valves



REDUCES to a minimum the friction on Steam Engines. We sell them with a guarantee to work to your satisfaction or your money refunded.

Wrought Iron Pipe

NOT STEEL

Cut to any size and for any purpose. Prompt Shipments to any part of the world guaranteed

Engineers' Supplies and Steam Fitters' Tools

C. J. RAINEAR & CO.

No. 518 ARCH STREET - - Philadelphia

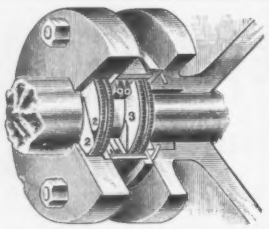
WE MAKE A SPECIALTY OF MANUFACTURING

Pure Tri-Sodium Phosphate

PRICES WILL BE QUOTED UPON APPLICATION

NATIONAL CHEMICAL COMPANY

Chestnut Hill, - - - - Philadelphia, Pa.



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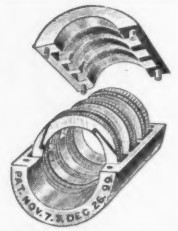

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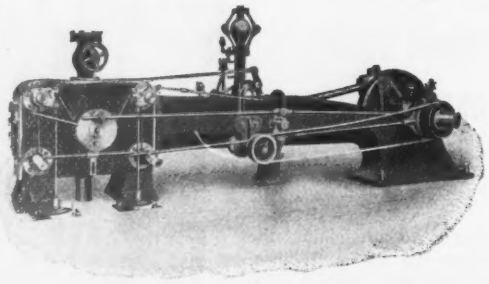

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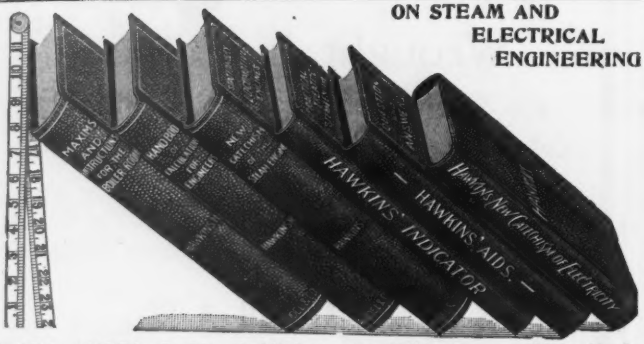

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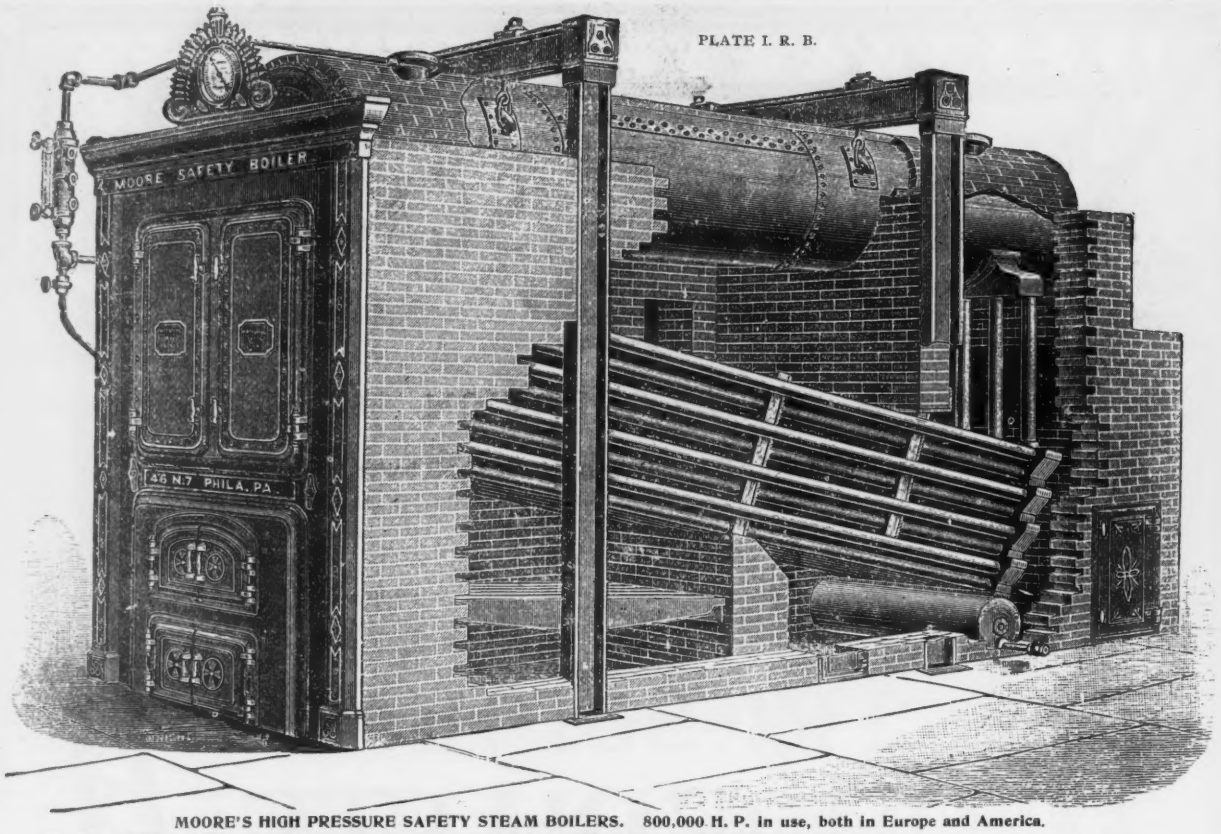

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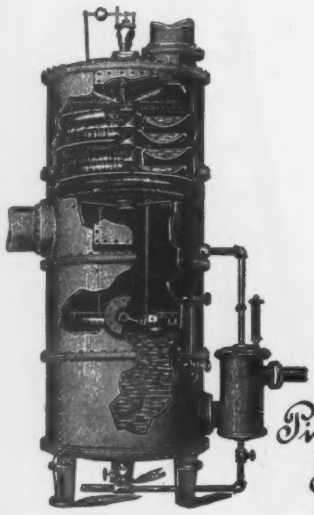

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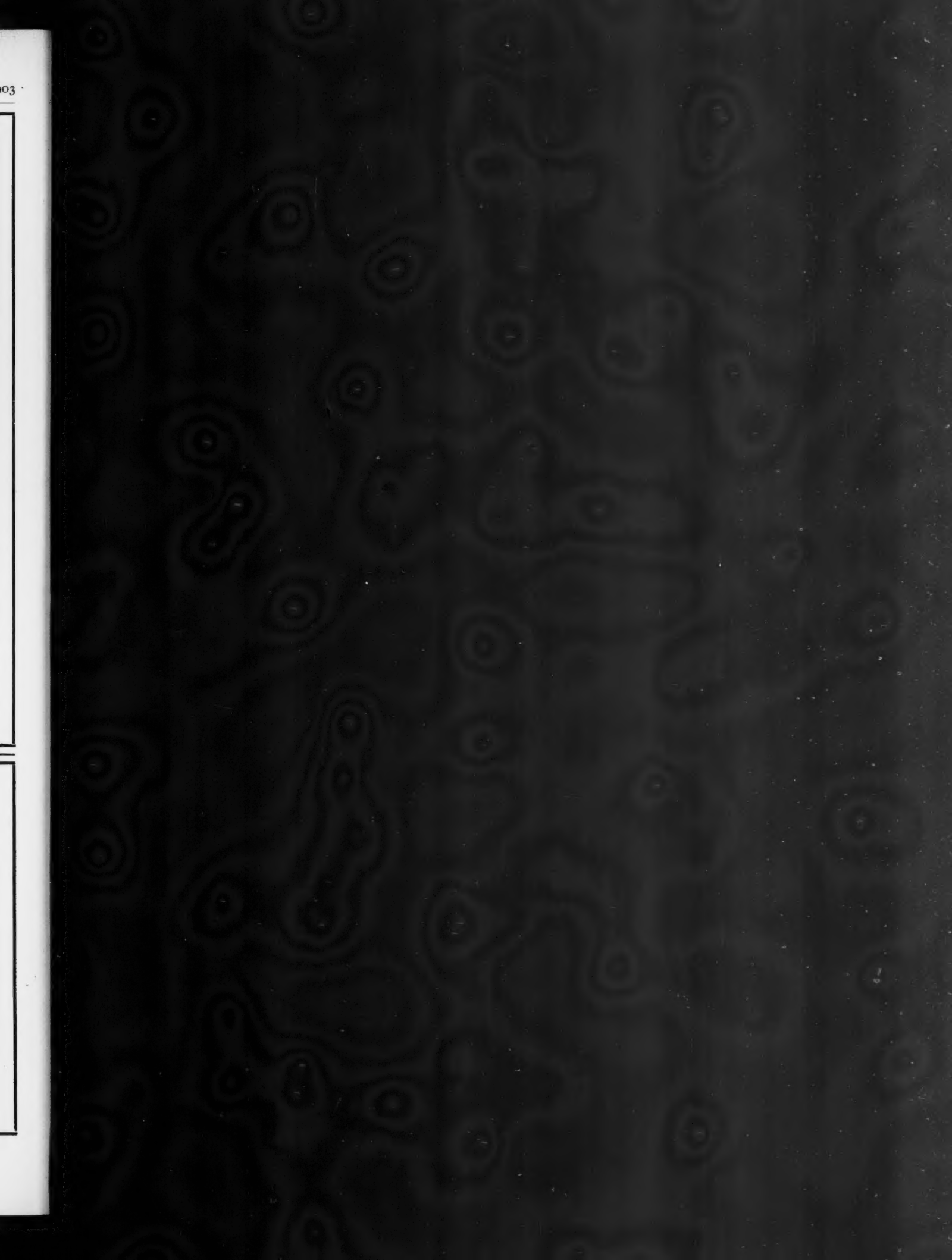

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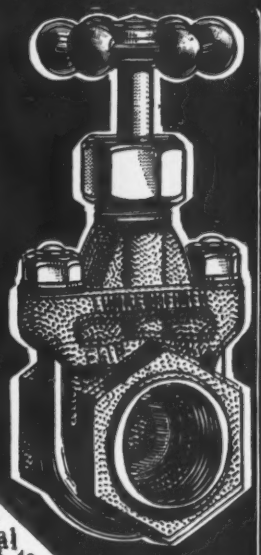

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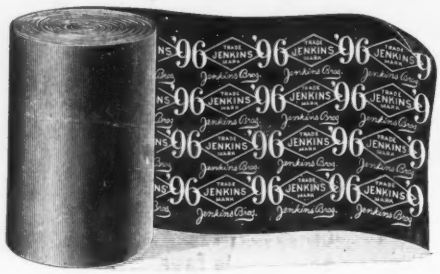

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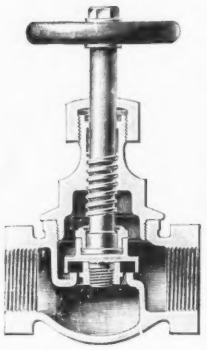

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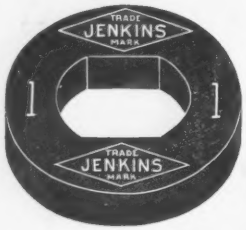

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